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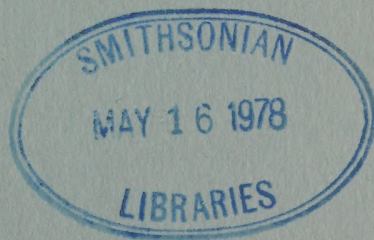
LEPIDOPTERISTS' SOCIETY

Published quarterly by THE LEPIDOPTERISTS' SOCIETY

Publié par LA SOCIÉTÉ DES LÉPIDOPTÉRISTES

Herausgegeben von DER GESELLSCHAFT DER LEPIDOPTEROLOGEN

Publicado por LA SOCIEDAD DE LOS LEPIDOPTERISTAS



14 March 1974

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A SYNONYMIC LIST OF THE NEARCTIC RHOPALOCERA
by CYRIL F. DOS PASSOS

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JOURNAL OF THE LEPIDOPTERISTS' SOCIETY

Volume 28

1974

Number 1

THE RELATIONSHIP OF *HOLOMELINA COSTATA* (STRETCH) AND *H. INTERMEDIA* (GRAEF), WITH REVISED SYNONYMY (ARCTIIDAE)

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While on a field trip in Texas in June 1972, I became curious as to why all of the examples of *Holomelina costata* collected were males and all of the *H. intermedia* were females. A live female of *intermedia* from Junction, Kimble Co., was therefore kept for eggs, the larvae reared on *Plantago major* L., and adult progeny of both sexes subsequently obtained (Figs. 1-3). The reared males are *costata* and the females are *intermedia*, showing conclusively that these names as used refer to male and female of the same species.

It is not especially surprising that this relationship has remained undetected for 85 years. The sexual dimorphism is extreme, males somewhat resembling the immaculate form of *Holomelina ferruginosa* (Wlk.), and females appearing as large, rather pale *H. laeta* (Guérin). Also, there are many other species of which only one sex, usually the male, is commonly collected. For example, in the same genus, hardly more than 1% of the field collected specimens of *H. ferruginosa* and *H. ostenta* (Hy. Edw.) in collections are females. I have collected well over 100 specimens of *ferruginosa* in the Northeast without ever catching a female; whereas females of the *aurantiaca* and *opella* complexes are much more frequently taken. Thus it has been supposed that only males of *costata* were attracted to light, and that the males of *intermedia* were diurnal or for some other reason missed by the usual collecting procedures.

The myth that both sexes of the two "species" had been collected was initiated by Edward L. Graef (1887: 42), who described *opelloides* from "1 ♂ and 1 ♀," and *intermedia* from "1 ♂." The type of *intermedia* is actually a female, and the types of *opelloides* are undoubtedly both

males, although I am certain of having found only one of them. Similarly, the two types of *Crocota diminutiva* Graef, described on the same page, are males, although stated to be male and female. Clearly, Graef had difficulty determining the sex of his specimens. For *costata* Stretch (1885: 103) and *cocciniceps* Schaus (1901: 269) the sex of the types was not mentioned at all. Examination of all the material in the U.S. National Museum and in the collection of Mr. André Blanchard of Houston, comprising a total of 198 males and 45 females, further verified the conclusion that all "*costata*" are males and all "*intermedia*" are females.

This discovery necessitates a rearranged synonymy. The types of five of the six names involved are in the U.S. National Museum and may be identified without difficulty. I have not seen the type of *costata*, but an example in the U.S. National Museum was compared with what was believed to be the type by F. H. Benjamin and is so labelled. This information, plus the original description and knowledge of what occurs in the type locality, leaves little doubt as to its identity. *Holomelina fragilis* (Strecker), based on a male from Pagosa Springs, Colorado, does not belong with *costata* but is very closely related to *ferruginosa*, apparently replacing the latter species in the Rocky Mountain region.

The following revised synonymy should be substituted for that of the McDunnough check list (1938: 49):

Holomelina costata costata (Stretch). Figs. 1-6.

Crocota costata Stretch, 1885: 103.

Type locality: Texas.

Types: Number of specimens and sex not given. Collected by Belfrage and in collection of California Academy of Sciences, San Francisco.

Crocota opelloides Graef, 1887: 42.

Type locality: Texas.

Types: Said to have been based on one male and one female, but both are now believed to be males. In the United States National Museum there are two males from the Graef collection that are probably the two original type specimens, but only one of these bears Graef's type label. I hereby designate it the lectotype of *opelloides* (Fig. 4).

Crocota intermedia Graef, 1887: 42. NEW SYNONYM.

Type locality: Texas.

Types: One female in the collection of the United States National Museum (not a male as stated in the original description). The type (Fig. 5) is slightly aberrant in having the outer dark border of the hindwing unusually wide, occupying the distal half of the wing.

Holomelina costata parvula (Neumoegen and Dyar). Figs. 7-9.

Crocota intermedia var. *parvula* Neumoegen and Dyar, 1893: 140. REVISED STATUS.

Type locality: Western Colorado.

Types: Female holotype (Fig. 8), collected by Bruce, in U.S. National Museum.



Figs. 1-9. *Holomelina costata*: (1) *H. c. costata* (Stretch) ♂, Junction, Kimble Co., Texas, reared 28 August 1972, D. C. Ferguson; (2) *H. c. costata* ♀, reared 24 August 1972 from same brood as specimen shown in fig. 1 (left forewing slightly deformed); (3) *H. c. costata* ♀, Junction, Kimble Co., Texas, 18 June 1972, D. C. Ferguson. Parent of specimens shown in fig. 1-2; (4) *H. c. costata* ♂, lectotype of *opelloides* (Graef); (5) *H. c. costata* ♀, holotype of *intermedia* (Graef); (6) *H. c. costata* ♀, Mayer, Yavapai Co., Arizona, 23 July 1959, R. F. Sternitzky; (7) *H. c. parvula* ♂, lectotype of *pallipennis* (B. & McD.); (8) *H. c. parvula* (N. & D.) ♀, holotype; (9) *H. c. parvula* ♀, holotype of *cocciniceps* Schaus.

Holomelina cocciniceps Schaus, 1901: 269. REVISED STATUS.

Type locality: Manitou, Colorado.

Types: Number of specimens and sex not given, but the specimen labelled as the type in the U.S. National Museum is a female and probably a holotype (Fig. 9).

Eubaphe costata pallipennis Barnes and McDunnough, 1918: 85, pl. 14, fig. 14.

Type locality: Glenwood Springs, Colorado.

Types: Described from an unstated number of male syntypes of which there are at least nine in the collection of the U.S. National Museum. No holotype was mentioned in the original description, but the specimens are labelled as type and paratypes. I hereby designate as lectotype of *pallipennis* the specimen labelled "type" in McDunnough's handwriting (Fig. 7). This is not the example figured by Barnes and McDunnough, which, perhaps through some oversight, does not bear a type label. Their figured specimen is obviously one of the type lot, having been chosen to illustrate the new subspecies, and I think that it must be regarded as a paratype. Thus the type series consists of a lectotype and nine paralectotypes.

Holomelina costata costata occurs in central Texas from Johnson and Palo Pinto counties, near Fort Worth, south at least to Uvalde Co., thence

westward through the Big Bend and Davis Mountains region and southern New Mexico to Arizona, remaining quite uniform in appearance. Material from southern Colorado (and probably northern New Mexico) is somewhat different, the males (*pallipennis*) being larger and paler, the females (*parvula*, *cocciniceps*) having the dark border on the hindwing averaging narrower, and the dark brown outer border on the underside of the forewing weak or obsolete. As it may be considered desirable to continue distinguishing the Colorado form as a subspecies, I have arranged the above synonymy accordingly. *Costata* in Texas has two or more broods, adults occurring in every month from late April to the end of September. For *parvula*, data available to me are inadequate.

In our fauna, *Holomelina costata* appears most closely related to *H. laeta*, despite the normally immaculate males. Very rarely, the male of *costata* may have a complete, although very narrow, border on the hindwing. There is such a specimen in the U.S. National Museum from Alpine, Texas, which indeed does resemble a large, pale *laeta* of the narrow-bordered form. A Mexican species, *Holomelina semirosea* (Druce), is peculiar in having males that look almost exactly like large females of *costata*, and females, if correctly associated, closely resembling *ostenta*. Such a species could be overlooked in Arizona, and collectors should examine their specimens carefully for any males that look like females of *costata*. The frenulum is perhaps the most convenient sex character in this group, being a single spine in the male and an equally long tuft of bristles in the female. However, the bristles of the female frenulum may present a deceptive appearance, being so closely appressed as to be mistaken for the solid spine of the male.

I am indebted to Mr. André Blanchard and Dr. John G. Franclemont for the privilege of examining material in their collections.

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NOTES ON THE BIOLOGY AND DISTRIBUTION
OF THE CUCULLIINAE (NOCTUIDAE)

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This paper summarizes eight years of observing, rearing and collecting Cuculliinae by the author, primarily in southeastern Pennsylvania and southern New Jersey. These areas combined will be referred to as the Delaware Valley region. In addition, records from other collections are included. In all such cases, I have verified the determinations. A few records from the literature are also cited. However, the records in Tietz (1952) are generally ignored since these can not be readily checked, many are known errors, and many more are extremely dubious. A few of his most interesting records are mentioned.

Genera for which new information can be provided are discussed in full. Records from the southern United States are presented due to the scarcity of records from that region. Taxonomy follows Franclemont (in Forbes, 1954). Foodplant records are from that source and the Canadian Department of Forestry (1962, here cited as CDF), and many are included which were previously unpublished.

Major Regional Collecting Areas

PENNSYLVANIA

Auburn, Schuylkill County is a mixed hardwood area dominated by various oaks (*Quercus* spp.) with red maple (*Acer rubrum*), black birch (*Betula lenta*) and hickories (*Carya* spp.) as common associates. Hemlock (*Tsuga canadensis*) and Virginia pine (*Pinus virginiana*) are common and scattered pitch and white pines (*P. rigida* and *P. strobus*) occur. The elevation is approximately 850 ft. All records here are from Eric L. Quinter.

French Creek State Park, Berks and Chester Cos., includes a variety of habitats such as dry ridges up to 900 ft. which are forested by oak sprouts of moderate to small size with an understory of blueberry (*Vaccinium vacillans*) and huckleberry (*Gaylussaccia baccata*) as well as wooded swamps dominated by mature red maples along with ash (*Fraxinus* sp.), elm (*Ulmus* sp.), with pin oak (*Quercus palustris*) and tulip tree (*Leriodendron tulipifera*) as common associates, and spicebush (*Lindera benzoin*), *Viburnum* spp. and highbush blueberry (*Vaccinium corymbosum*) forming the shrub layer. More mesic areas are forested with oaks, hickories, tulip tree and red maple with black birch and aspen (*Populus grandidentata*) also present. This area was collected with black light traps and bait traps, the latter in all habitats, by the author.

Strafford, Chester Co., is a residential area with some patches of native woods. These are of two types: nearly pure stands of moderate to very large tulip trees, and stands of mixed oaks. In addition wild and planted fruit trees are present. The elevation is about 600 ft. I collected this site almost daily for over seven years, using both light and bait.

Blue Mountain Bog, Schuylkill Co. is at 1600 ft. on a ridge covered largely by oaks. Around the bog itself trees include larch (*Larix laricina*) and paper birch (*Betula papyrifera*), neither of which grows generally in the region. Pitch pine and scrub oak (*Quercus ilicifolia*) occur in the immediate vicinity. Shrubs and sub-shrubs include cranberry and several species of blueberries (*Vaccinium* spp.). Eric Quinter has been the sole collector at this site, using mostly black light.

NEW JERSEY

Lebanon, Hunterdon Co., is very similar in flora and moth fauna to French Creek (above). Joseph Muller has collected here extensively for about twenty years. This is referred to as Stanton by Muller (1965).

The **Pine Barrens**, a unique faunal and floral region, covers much of Burlington Co., practically all of Ocean Co. and southward, except along the Delaware River and immediate coast, into Cape May County. The dry sandy "uplands" are forested almost exclusively with various mixtures of oaks and pines with an Ericaceous understory. The exact composition is determined largely by frequent and often extensive forest fires that sweep through these areas, usually in April. The oaks are chiefly *Quercus ilicifolia*, *marilandica*, *stellata*, *velutina* and *coccinea* but others occur. The pines are almost exclusively shortleaf (*P. echinata*) and pitch (*P. rigida*) with stands of *P. virginiana* on the western fringe of the region and *P. serotina* and *taeda* on the southern fringe. Throughout the region are many swamps. Some are nearly pure stands of *Chamaecyparis thyoides*, known locally as cedar swamps. Others are mixtures of red maple, sour gum (*Nyssa sylvatica*) and *Magnolia virginiana*. In addition "pitch pine lowlands" composed of pitch pine and various combinations of swamp species are abundant. In all lowlands the understory is primarily Ericaceous. Bogs and boggy meadows are very widespread. Collectors interested in exploring this region should consult McCormick (1970) for more details on the flora. The diversity of the area as well as its combination of characteristically boreal and southern plants and moths makes it one of the truly outstanding collecting areas in the eastern states.

Collecting in the Pine Barrens has been concentrated at Lakehurst where Frederick Lemmer, Otto Bucholz, John W. Cadbury III, and Joseph Muller have collected extensively. Excessive fires and cutting, and to some extent development, have greatly depleted the Lakehurst area, especially the swamps. Formerly all Pine Barren habitats were present and well collected. Other collecting sites in the Barrens have been at New Lisbon in a mixed swamp where Cadbury and I have collected, and a similar area at Whitesbog where Cadbury collected. I presently collect rather extensively around Batsto in a variety of habitats. The fact that all of these collectors have made extensive use of bait has resulted in the accumulation of a vast number of specimens of Cuculliinae.

The Atlantic coastal plain outside of the Pine Barrens in New Jersey has been virtually uncollected for moths. Cadbury did collect at street lights in Moorestown and Mt. Holly, but took few Cuculiinae, as would be expected with this method.

TRIBE LITHOPHANINI

Members of this tribe fly during the cooler seasons only, aestivating as larvae in the soil during the summer. In the Delaware Valley region, most of the species seem to emerge in late October or November, although in 1971 they did not appear in numbers until well into December. October had been very warm. However, *Metaxaglaea viatica* adults emerging in early October 1972 remained lethargic until early November

when mating occurred. There is strong circumstantial evidence that other species may be present but inactive in October. Most of the species overwinter as adults, at least sometimes in the fallen leaves on the ground. In these species development of the eggs within the females is not evident upon dissection until at least the end of January. Mating occurs from late January to mid-March in *Eupsilia* spp., by mid-March in *Lithophane grotei*, but apparently usually not until well into April in *Lithophane hemina*, *patefacta*, *querquera*, and *viridipallens*. The fact that egg development occurs in at least some species during midwinter seems to indicate that no true diapause occurs. In addition large numbers of *Eupsilia* spp. can be taken at bait on almost any warm winter night, when the temperature is above 42°F. *Lithophane* spp. are also taken on such nights, but not in large numbers. Rainy nights are generally far more productive than clear ones when the temperature is lower than 50°F.

Even when nights are too cold for flight, the moths are not completely inactive. Caged *Eupsilia* and *Lithophane* will crawl out of their shelters to take water on rainy afternoons, and also will crawl about probing with their proboscis on sunny winter days. In either case the temperature is often under 40°F. On cold nights the moths may crawl about in search of better shelters, which are located at least in part by probing with the antennae. This has been observed repeatedly at subfreezing temperatures for a variety of species: *Lithophane viridipallens*, *antennata*, *unimoda*, *grotei*, and *patefacta*; *Eupsilia vinulenta*, *sidus*, *morrisoni*; *Epiglaea decliva*. The minimum temperature for activity seems to be 28°F.

Suitable shelters are essential for winter survival. The moths always rest with the abdomen pressed against some surface and the wings closed tightly over it. The thorax is not covered, but is densely hairy. The head is tucked up tight against the thorax and the antennae are folded under the wings. One night, three *Eupsilia vinulenta* were dislodged in a cage and fell onto their backs. The temperature was about 28°F. By morning, two were dead, but the other had righted itself and crawled under a leaf. About a dozen others in the box, under leaves or on the sides, survived the night which fell to at least 21°F. For prolonged survival the moths crawl deep into leaf litter in cages. Almost invariably they crawl into a folded over leaf. Probably water retention, rather than direct temperature effects, necessitate the use of shelters. Refrigerated moths will survive several months in tightly closed containers, but only a few days in well ventilated ones, in frost-free refrigerators. Similar observations have been made outdoors in cold

spells. In fact, it is quite possible that lack of protective snow cover in the southern states may be a limiting factor for these moths. Certainly, they are essentially a northern group.

Little is actually known of the resting habits of these moths in the field. I have seen *Eupsilia* and *Sunira bicolorago* fly up from leaf litter on several occasions. However, T. D. Sargent (pers. comm.) has taken *Eupsilia vinulenta* at light in Massachusetts on nights when the ground was completely snow-covered. Presumably these moths had been under loose bark, or in hollow trees. The brown *Lithophane* look as if they might hide under loose bark, although caged individuals crawl under leaves. Certainly, *Lithophane lemmeri* looks like a perfect match for the bark of its larval host, white cedar. In addition, cedar swamps almost always flood in the winter. It seems that this species must overwinter in the shreds of bark that are typical of old cedars. *Lithophane thaxteri* and *lepida* also resemble the bark of some conifers, notably pitch and shortleaf pine. *L. pexata* also resembles bark in general. All three of these species characteristically rest on the sides of bait traps, head up. Other Cuculliinae rest in the dead leaves provided at the bottom of such traps.

In those species that do not hibernate as adults, the egg is the overwintering stage. These are laid in the autumn or early winter, well into December, in *Metaxaglaea viatica* and *Epiglaea decliva*.

Larvae of this tribe hatch in the spring from late March into early May depending on the species. Most of them can survive for well over a week without food, provided humidity is high, at room temperatures. This ability would minimize losses from early emergences. Most or all of the species will accept catkins and these are apparently the normal initial food source for *Sunira bicolorago* and *Anathix* spp. (Forbes, 1954). I am aware of only one species, an undescribed *Metaxaglaea*, which is an obligatory catkin feeder. I find that *Sunira* larvae will eat any part, including the wood, of practically any plant. Unlike most of the species however, *Sunira* larvae are not predatory. In general, most species probably start feeding on newly opened leaf buds. As the larvae mature they feed on the leaves and flowers and, in some *Lithophane* at least, on fruits as well. In my experience *Lithophane* larvae are extremely predatory in captivity. It seems likely that they eat other caterpillars in natural conditions as well. This would certainly be an adaptive habit when competition with other species is acute as sometimes happens during canker worm (Geometridae) outbreaks. Cannibalism might also be adaptive as a means of population control. *Lithophane* larvae will also eat dead larvae and frass in captivity.

In general the moths are most often taken at a variety of baits. I usually use a mixture of rotten apples, crushed bananas, brown sugar, and molasses. This mixture is allowed to ferment for at least three days before use. Beer may be added if fermentation is inadequate. These baits last about one month, longer if they are refrigerated when not in use. Naturally rotted apples and quinces also make excellent bait. Baits may be smeared on tree trunks or placed in dishes. Apparently they must be at least four feet above the ground. Joseph Muller and I have also had success with bait traps. Ours are similar in basic design to that described by Platt (1969) except that they are made of metal with pie pans as lids. Great care must be taken to assure that the lids fit snugly. These traps are hung from tree limbs. I check mine once a week or less.

Another excellent method of collecting these and other noctuids is to net them from pussy willow blossoms just after dusk. The moths may also be obtained by shaking the tree as they will usually fall to the ground rather than take flight. I have taken six species of *Lithophane* and three of *Eupsilia* at pussy willow at Strafford. This total includes all except the rarest members of the tribe that fly at that site in the spring. Other blossoms might prove effective as well. Holland (1903) notes that "*Scopelosoma*" (i.e. *Eupsilia* and *Pyreferra*) come to maple sap buckets.

In general, lights tend to yield poor returns. However, the setup used by Sargent at Leverett, Massachusetts is quite effective. This consists of a Robinson Trap, a 15-watt black light, and four 150-watt floodlights. On 16 March 1973, Sargent and I were able to compare his lights with ten baited trees. Twenty-two species were taken. A total of 212 specimens of 21 species was taken at the bait, while 69 specimens of 14 species were taken at light. During the course of the spring, bait proved most effective for all members of the tribe except *Homoglaea hircina* which appeared only at light. In general the proportion of specimens at light seems to increase sharply in mid-April in both Pennsylvania and Massachusetts.

The effects of weather on the activity of these moths are only partially understood. Observations on captive individuals suggest 47°F as the minimum temperature at which *Lithophane patefacta* will take flight. Similarly, the minimum for *Eupsilia* spp. was found to be 42°F. However, clear cold nights following warm, sunny, spring days will often produce substantial catches even with temperatures at dusk as low as 36°F. Apparently the hairiness of the moths enables them to retain body heat, even with rapidly falling temperatures. Such captures are almost always

within one hour of dusk and usually at light. Certainly, any night with the temperature at dusk above 50°F is likely to be productive.

Xylena Ochsenheimer

The larvae of this genus are brownish, climbing cutworms in the last instar; green with white markings in the earlier instars, resting then in the foliage. They appear to be very general feeders.

X. nupera (Hübner) has been taken at Lakehurst by Muller and Cadbury, and once at Batsto by myself. Dates span from 16 September to 30 April. It is clearly very rare in the region. Tietz (1952) records it from Delaware and Berks Cos., possibly correctly.

X. curvimacula (Morrison) is quite general in the region. It is common only in Schuylkill Co. where Quinter finds it at several sites. It is very scarce in the Pine Barrens and not taken at Batsto. The moth flies from late October to late April, most captures are in April.

X. cineritia (Grote) was taken by Lemmer a few times at Lakehurst in the 1930's and 1940's. Quinter has taken it in substantial numbers at Blue Mountain Bog, Auburn, and nearby New Ringold. Tietz reports it from Reading, Pennsylvania. The species is not known from south of this region. Records are from October to April.

Lithophane Hübner

This genus is somewhat heterogeneous. The first group, through *oriunda*, is distinctive in adult maculation and genitalia. The larvae are brown or gray in the last instar with a mottled pattern as described by Franclemont (in Forbes, 1954). The earlier instars are green with the ordinary lines and tubercles contrastingly white. The green instar larvae rest by day on the foliage of the host tree. The last instar of at least *bethunei* is a climbing cutworm, resting by day in bark crevices and among debris at the base of the tree. One last instar *hemina* larva has been found on a twig of boxelder.

The generic name *Grapolitha* (Hübner) was based on *L. socia*, a European member of this group (Franclemont, 1942). The adults of most of these species are dimorphic (Franclemont, 1942; Forbes, 1954). Adults of this group are very rarely taken in January and February in this region.

L. semiusta (Grote) is extremely rare in the region. Lemmer took one at Lakehurst dated 1 to 10 May (specimen in the American Museum), and Muller has taken one at Stanton, 18 October 1953. Lemmer did not include years on his labels. Tietz (1952) states that the United States National Museum has one from White Mills, Wayne Co., Penn-

sylvania dated in August. The species is northern and Lakehurst is the most southern capture. It ranges west at least to Wausau, Marathon Co., Wisconsin (Jim Parkinson, in Schweitzer collection). The larva occurs on basswood and accepts choke cherry (Forbes, 1954; CDF).

L. bethunei (Grote and Robinson) is fairly general in the region except for Schuylkill Co. where Quinter has not taken it. Otherwise it is usually common outside of the Pine Barrens, where however, it is present. Larva, on many trees (Forbes, 1954; CDF). I have reared them on oak, *Prunus* spp. and apple, and have found two larvae on trunks of black oak trees in bark crevices at Springfield, Delaware Co., Pennsylvania. It flies from October through April, but is taken much more often in spring. Only the typical form has been taken locally.

L. innominata (Smith) was taken at Lakehurst by Buchholz (American Museum) from October to April, and at Auburn, 28 April 1972. Otherwise the only regional record is the Wayne Co., Pennsylvania specimen noted by Tietz (1952) as being in the United States National Museum. There are no records from south of this region. Only the normal form *illecebra* (Franclemont) has been found in the area.

L. patefacta (Walker) has been taken by all collectors at all Pine Barren sites. It is very common some years, very rare others. It does not occur, so far as known, anywhere else south of the vicinity of Ithaca, New York. Tietz's record (1952) for western Pennsylvania is probably an error, and Muller's record (1965) from Stanton is known to be so. I have reared it on *Prunus* spp. and commercial blueberry leaves. It eats the leaves, flowers and fruit of the former. The typical and *niveocosta* (Franclemont) forms are of nearly equal abundance. Mating takes place in late March and early April.

L. hemina (Grote) is apparently general in the region, but is quite rare in the Pine Barrens where it has been taken only at Lakehurst by Cadbury and Lemmer. It is common at Lebanon, Auburn, and French Creek, where it seems to have no habitat preference. It is not common at Strafford. Other area records are Valley Forge Park, Pennsylvania, and Moorestown, New Jersey. It flies from mid-October to as late as 30 April. I have attempted four times to obtain ova from females baited in early April, but all laid only sterile eggs. I have also found a larva on a boxelder (*Acer negundo*) twig at Wissahickon Ravine, Philadelphia, 11 June 1973. The only known records south of this region are a specimen taken by Quinter at black light at Ice Mountain, Hampshire Co., West Virginia, 24 April 1971; and an apparent specimen from C. V. Covell taken at Valley Station, Kentucky, near Louisville, November 1972 by Siegfried Schloss. Twenty out of 32 regional specimens in the author's

collection are the variety **lignicosta** (Franclemont). It feeds on many trees in captivity.

L. petulca (Grote) ranges as far south as this region. It is probably common at Auburn since a small series has been accumulated solely at light. I took it once at French Creek (genitalia checked). Muller gets it at Lebanon. The American Museum has eight specimens under this name from Lakehurst, but some are almost certainly *L. signosa*. At least two are correct, however. Both forms occur in the region. Usually, there is some violet shading at least along the costa of the primaries. The larva feeds on many trees (CDF).

L. signosa (Walker) is not common, but is found at Strafford, French Creek, Lebanon, Batsto, Moorestown, Lakehurst, and Whitesbog. I also took one in a crevice on the trunk of a ginkgo tree at Overbrook, Philadelphia Co., Pennsylvania, 18 November 1968. The larva and food are unknown, but the species is apparently a restricted feeder (Forbes, 1954). This is apparently the most southern species of this group. Its known range is from Bristol, Rhode Island and Randolph, Vermont (Franclemont, 1942) to Arlington, Virginia (Forbes, 1954) and Clinton, Hinds Co., Mississippi (Bryant Mather, 10 March 1960; determined and genitalia checked by the author, form **pallidicosta** Franclemont), and Lafayette, Indiana (Franclemont, 1942). The lack of records from Canada is noteworthy. Nine of my seventeen regional specimens are the form **pallidicosta**. One of these has the suffused area reddish brown instead of the usual blackish, as does the Mississippi specimen. Dates range from 11 October (Strafford) to 4 May (Moorestown, 1941).

L. disposita (Morrison) is extremely rare in the region. It has been taken at Lakehurst, 20 April 1952 (Muller) and 18 October 1946 (Cadbury); Wayne, Delaware Co., Pennsylvania, 16 March 1965 (Schweitzer, on store front); Auburn, 24 September 1972; and Philadelphia, 19 November 1902 (Quinter coll.). Tietz reports it from White Mills, Wayne Co., in August, based on a specimen in the United States National Museum.

L. oriunda (Walker) has been taken twice at Scranton (AMNH).

The larvae of the following species (second group) are green in all instars so far as known and remain in the foliage by day. The adults are generally shades of grey and are usually monomorphic. The adults are fairly frequent in mid-winter. Mating seasons are variable between species. Some of the larvae are restricted feeders. The name *Lithophane* was based on a species related to our *pexata*.

L. lamda (Fabricius) race *thaxteri* (Grote) is reported in eastern Pennsylvania at White Mills and Reading by Tietz (1952). This species

would be hard to misidentify. I cannot verify its presence in that state. It is, however, common some years in the Pine Barrens where it has been taken at Lakehurst (Cadbury, Lemmer) and Batsto. The local foodplant is unknown. The host reported by Forbes (1954), *Ceanothus*, is not present in the Barrens. *Myrica* is listed for the typical, European, race and Douglas fir (*Pseudotsuga*) for the Pacific Northwest population. Brower has one from Maine (ex larva) on *Myrica gale* but throughout much of Canada the principal host is larch (CDF). Thus our population might be expected to feed on *Myrica pennsylvanica* or pine or white cedar. It is possible that several species are involved. It seems certain that this is not a general feeder. It flies October to April.

L. pexata (Grote) is not common in the region, but has been taken at Lebanon, Lakehurst, Weekstown (Atlantic Co., Pine Barrens), French Creek and in Schuylkill Co. at Auburn, New Ringold and Blue Mountain Bog from October to April. The principal host seems to be alder, but birch has also been reported (CDF). Quinter finds only the alder to be acceptable.

L. fagina (Morrison) is a northern species that extends south into the Pine Barrens where it is usually rare. It has been taken at Batsto, New Lisbon, and Lakehurst. Area dates are from 21 September (Cadbury) to mid-April. In Massachusetts, the species seems to mate rather late in the spring. The larva has been collected in Canada on birch twenty three times and once on pin cherry (CDF). Presumably, the food in the Pine Barrens is *Betula populifolia*. The young larva is similar to *L. tepida*.

L. tepida (Grote) is very rare in this region, having been taken at Lebanon, 23 November (Muller); and a few times at Auburn by Quinter. It has been reported from White Mills in August (Tietz, 1952). I have reared the larva (from Massachusetts), and birch and aspens seem to be the preferred hosts. It is very predatory, and will run down other larvae. The last instar is a somewhat yellowish green with slightly broken yellow ordinary lines and tubercles. It has been found on birch, willow, and gooseberry in Canada (CDF).

L. baileyi (Grote) is reported by Tietz (1952) from White Mills, in August, and has been taken at Lakehurst, 16 October 1946 (Cadbury). The larva has been reported on pine, birch and cottonwood (CDF).

L. querquera (Grote) is very rare in the Pine Barrens, having been taken only at Lakehurst by Lemmer and once at Batsto, but is less rare elsewhere. Records are for Lebanon (common), Auburn and French Creek. It may prefer red maple swamps. This species ranges south to

Clinton, Hinds Co., Mississippi where Mather has taken it once, 20 January 1969. I have seen the specimen. In the Delaware Valley region, both forms occur at all localities. The larva of this species is unique. It is uniform dark leaf green. The ordinary lines and tubercles are not visible except for a contrasting but poorly defined yellow spiracular line. There is a bright yellow transverse line at the posterior of each segment except on the anal hump. The anal hump and prolegs are contrastingly white. The ground color becomes gray in the last instar. It seems very unlikely that this is a cryptic species. It will accept a variety of hardwoods, but the newly hatched larvae seem to prefer paper birch and seem to dislike black oak. The larvae are extremely predacious and will also eat human epidermis when handled.

L. viridipallens (Grote) is usually not rare in pitch pine lowland habitats in the Pine Barrens where it has been taken at all localities collected, although it has not been taken at Lakehurst in over twenty years. Most records are from November to April, but there are a few in October. All specimens seen by me have been from along the Atlantic and Gulf coasts from Hampton, New Hampshire (Shaw, in Brower coll.) to Carteret Co., North Carolina (J. B. Sullivan) and McClellanville, South Carolina (R. B. Dominick) and Lauderdale Co., Mississippi (Mather). Tietz's reports (1952) from western Pennsylvania are extremely dubious. Nothing is known of the life history except that mating apparently does not take place until well into April in the Pine Barrens.

L. lemmeri (Barnes and McDunnough) occurs in the Pine Barrens where Cadbury and Lemmer found it abundant some years at Lakehurst, as late as the 1940's. More recently, Muller has not found the species and I have taken but one at Batsto, 12 April 1970. Dates are from October to 12 May. The food is white cedar according to Muller (1965). This information is from Lemmer who presumably reared it. Franclemont (1969) suggests that the food may be red cedar, but the distribution and habitat of the moth make this seem very unlikely. Other records are Ivoryton, Connecticut (Forbes, 1954) and McClellanville, South Carolina (Dominick). The South Carolina specimens seemed atypical, but I did not have other material available for comparison.

L. lepida (Lintner) is a northern species ranging into upper New York State in its typical form. The race *adipel* (Benjamin) occurs only in the New Jersey Pine Barrens and was sometimes taken abundantly by Cadbury and Lemmer at Lakehurst, and was common in December 1972 at Batsto, but very rare other seasons. I have found it only in pitch pine lowland habitats, despite more extensive baiting in drier sites. The type race feeds on pines (Forbes, 1954; CDF).

L. antennata (Walker) is completely general in this region and always common, especially at French Creek. It is often numerous as early as late September and occasionally flies into early May. The larva feeds on most hardwoods, eating fruits and galls as well as leaves (Holland, 1903; Forbes, 1954). I have seen specimens from Hinds Co., Mississippi (Mather) and have a series from Pine Mt., Kentucky, 22 October 1970 (Cornett, received from Covell).

L. grotei (Riley) is another common, generally distributed species in the Delaware Valley region. It appears later and disappears earlier than *antennata*, most records ranging between November and March. I have reared it from eggs found on *Prunus serotina* at Strafford, and Brower informs me that it sometimes causes substantial defoliation of soft maples in Maine. The early mating and oviposition suggest that the larvae may begin to feed on catkins in some cases.

L. laticinerea (Grote) is surprisingly rare in this region and most specimens seen labelled this are *grotei*. It is known from Lakehurst, Batsto (one, November 1968; and a larva on *Quercus velutina*, 25 May 1969), Strafford (1 November and 19 December 1967, 22 January 1973 and probably 8 April 1970), and Auburn, where it is also quite rare. The species ranges south to Clemson, South Carolina (22 February 1939, E. C. Sturgis, in Schweitzer coll.). Dominick has a specimen from McClellanville, South Carolina which superficially resembles this species, taken 16 February 1970. This species closely resembles *antennata* but averages larger, and slightly darker and duller. However, at least in the Delaware Valley area it is best to check the male genitalia with the figure in Forbes (1954). The presence of a basal dash on the primaries will distinguish this species from *grotei* which is also much darker and more mottled.

L. unimoda (Lintner) is completely general in this region and is usually common except perhaps in Schuylkill Co., where, however, more collecting at bait might turn up larger numbers. It seems to be common in almost any habitat. Franclemont (in Forbes, 1954) reports that the larva feeds by preference on black cherry, but the moth is clearly not associated with this plant in this area.

Eupsilia Hübner

The moths of this genus make up the majority of mid-winter moth catches in this area. They fly from late September (very rarely) into late April. Eggs develop in January and matings occur from the end of that month into March. The moths are sometimes difficult to identify but the following generalizations seem safe. *E. vinulenta* (Grote) and

E. sidus (Guenée) are general and common in the region and fluctuate in numbers from year to year. *E. morrisoni* (Grote) is usually rare in the Pine Barrens, but common elsewhere. *E. tristigmata* (Grote) is common in the Pine Barrens and general, but rare, in the rest of the region. *E. cirripalea* (Franclemont) may be common in the Pine Barrens, but is definitely rare elsewhere, though taken at Strafford and the Nottingham (Chester Co.) pine barren area. *E. devia* (Grote) is rare throughout the region, except at Lebanon. It is unknown from Schuylkill Co. so far. The larvae of all the species are described by Forbes (1954). I have reared the larvae of most of the species on various trees and shrubs. They will eat dandelion as well. The young larvae make a crude silk nest between two leaves. They are solitary. The mature larvae hide in debris at the base of trees and probably in bark crevices as well.

Pyreferra Franclemont

P. hesperidago (Guenée) has been taken at Lebanon, Auburn, Strafford and Valley Forge Park which are within the range of the foodplant, *Hamamelis*, reported by Forbes (1954). However, this plant does not grow in the Pine Barrens although the moth has been taken a number of times by Cadbury at Lakehurst. Possibly, sweet gum, *Liquidambar styraciflua*, which is in the Hamamelidaceae is the foodplant there.

P. citromba (Franclemont) has been taken at the same places as the last species. Likewise, its reported foodplant, *Corylus*, does not grow in the Pine Barrens. Birch, *Betula populifolia*, seems to be the most likely host there. *Corylus* is also quite uncommon in the Delaware Valley region as a whole.

P. pettiti (Grote) has been taken once by Muller at Lebanon. Since it feeds on *Betula lenta* and *B. lutea* according to Forbes (1954), its rarity in this region is remarkable.

P. ceromatica (Grote) has not been taken in this region so far as I am aware.

All of the species apparently fly from October through April. They have not been taken in mid-winter.

Homoglaea Morrison

H. hircina (Morrison) is somewhat surprisingly established this far south. Muller has a series from Lebanon; Quinter has several from Auburn; and I have one from Strafford. It flies from October to April. The larvae web together aspen leaves upon which they feed (Forbes, 1954).

Sericaglaea Franclemont

S. signata (French) is fairly common in the Pine Barrens, having been taken at all the usual locations, including a swamp near Weekstown and also at a site east of Berlin (Quinter). Otherwise, the only area records are singles from Strafford, and French Creek. Dates run mid-October into April, except the Berlin specimen which is 2 May 1970. I have examined the Florida specimens in the American Museum and am fairly sure they are variants of *C. tremula*. However, the species appears to be widespread in the south. Bryant Mather takes it commonly in Hinds Co., Mississippi, and Dominick has a series from McClellanville on the coast of South Carolina. Ric Peigler has taken it at Greenville on the Piedmont of that state. The Clemson University Entomology Department has one from Florence, also on the coast. In the south dates are December to March.

The genus *Metaxaglaea* (Franclemont) will be treated in a later paper which will include a description of a new species from the Pine Barrens and south.

Epiglaea Grote

E. decliva (Grote) is completely general in this region. It is usually not uncommon, but the only record of it occurring in abundance is at the pine barren area near Nottingham, Pennsylvania, 16 October 1971, when each of about 35 baited trees had several individuals each time they were checked. Since this is the earliest regional date, it is likely that the species had not yet reached peak abundance. The latest record is for seven specimens at Strafford, 31 December 1972. The females in this lot produced largely sterile eggs but each produce some viable ones. I once found a last instar larva feeding by night on the lowest limb of an apple tree at Strafford. I have reared the species on *Prunus* spp. The larvae rest by day on the branches. The last instar larva probably hides in bark crevices or on the ground.

E. apiata (Grote) is nearly limited to the Pine Barrens in this region. It is general and abundant in them from late September into November. The only other locality for the species is Lebanon where Muller took a male on 10 April 1952. This date is quite remarkable. The specimen appears too fresh to have overwintered. The normal food is cranberry, but it has been reported from blueberry (Forbes, 1954). The species occurs in the coastal plain south to North Carolina (Fort Bragg, R. A. Anderson, Carteret Co., J. B. Sullivan) and McClellanville, South Carolina (Dominick). Southward, most records are in November. Northward, the species is not limited to the coast.

Chaetagnalea Franclemont

C. sericea (Morrison) is a very widespread species and is quite general in the Delaware Valley region. It is common all over the Pine Barrens. It was also taken in numbers in a burned over area dominated by sprout oaks over blueberry at Resica Falls, Monroe Co., 28 October 1971, and on the pine barren area at Nottingham, Chester Co., 16 October 1971. Otherwise it is uncommon in the region in my experience. The species occurs on the coastal plain in North Carolina (Carteret Co., Sullivan) and South Carolina (Florence Co., Clemson University coll.; McClellanville, Dominick). Kimball (1965) reports it in Florida. I have also seen one from Mather's collection from Newton Co., Mississippi. In the Delaware Valley area, the species flies from late September into December, mostly in October. Forbes (1954) describes the larva and I have reared it on *Prunus* spp.

C. tremula (Harvey) ranges along the coast from Bar Harbor, Maine (Brower) to Florida and Texas. Brower also has it from inland at Scranton, Pennsylvania and Bear Mountain, New York. In the Delaware Valley region it is abundant in the Pine Barrens mostly in late September and early October, but not taken elsewhere. I have reared it on *Prunus* spp. and find the larva identical to *sericea* except that some individuals have a blue tint dorsally. The eggs of this species are usually attached weakly, if at all, to any substrate and presumably fall to the ground in the winter. Thus the larva probably feeds on shrubs.

C. cerata (Franclemont) has an unusual distribution, ranging from Mystic, Connecticut (holotype, Franclemont, 1943), up the coast to at least Hampton, New Hampshire (Shaw, in Brower coll.) and also inland at Augusta, Maine (Brower, 18 September 1968). It also occurs in Pennsylvania at Finleyville (presumably the one in Allegheny Co., Engel's usual collecting area, although there is such a town in Bedford Co. as well), and at Auburn where it is rather common. All records, except the Maine one, are in October.

Psectraglaea Hampson

P. carnosa (Grote) is general and often common in the Pine Barrens, at least south to Batsto. Adults may often be found on the red leaves of blueberry and huckleberry (Muller, Cadbury, Forbes (1954)). They also come to bait and light. In Pennsylvania, it is known from near Mt. Pocono (T. Lis, in Schweitzer coll.) and reported from Drifton, Luzerne Co., September (Tietz, 1952). Presumably the Drifton specimen is the basis of Forbes' (1954) Luzerne Co. record. Most records are in October, but it flies into November. Muller (1965) reports huckleberry (*Gaylussac-*

cia) as the foodplant. Darlington (1952) writes that Buchholz reared the species on wild cherry and that blueberry was unacceptable.

Anathix Franclemont

A. ralla (Grote and Robinson) is fairly common at French Creek, Auburn and Lebanon; less common at Strafford; and not seen from the other sites, although Rummel is reported (Anon., 1923) to have taken a specimen, 6 September 1922, at Lakehurst. It flies in this area from late August into October, most commonly in late September.

A few genera in this tribe have not been discussed above. Of these, *Hillia*, *Xanthia* and *Lithomoia* are apparently not represented in the Delaware Valley. The others contain widespread species which are general and common in the region.

TRIBE ANTITYPINI

Anytus Grote

A. privatus (Walker) is known in this area by only one definite record, Resica Falls, Monroe Co., Pennsylvania, taken 25 August 1971 by the author. It is not different in any way from my New England series. Tietz (1952) reports it from Berks Co. in July.

A. teltowa (Smith) may be conspecific with *privatus* (Forbes, 1954). If so, I would retain the name as a subspecies. It has been taken in the Pine Barrens numerous times in late August and September, but it is seldom if ever really common there. I have seen similar specimens from coastal North Carolina (Carteret Co., Sullivan) and coastal South Carolina (Florence, in Clemson University coll.). Quinter has taken it once at Auburn.

Xylotype Hampson

X. capax (Grote) has been taken throughout the Pine Barrens where it is almost always common and sometimes locally abundant. Otherwise, it is known from Blue Mountain Bog and Nottingham Barrens. It is common at both places. It is also reported from Flourtown, Montgomery Co., Pennsylvania by Shapiro (1965). The American Museum has two Rothke specimens from Scranton. In cases where the habitat is known, pitch pine and scrub and/or blackjack and post oak have been common in the immediate vicinity. The primaries would be an excellent match for pitch pine bark. Most records are mid-October but there are a few in September and November. I have reared the larvae on a diet of red oak, wild cherry, crabapple and blueberry leaves. Pitch pine is not accepted. Forbes suggests *Vaccinium* is the preferred foodplant, but

species of this genus are not common at the Nottingham site. I suspect that the larvae feed on a variety of plants, but if they are restricted feeders, one of the shrubby oaks seems most likely in this area. In Alberta and Saskatchewan there is a spruce feeding population (CDF) but I suspect these may not be conspecific with *capax*. Larvae of *X. acadia*, which Forbes (1954) treats as a race of *capax*, have been reported from alder (3) and larch (1) (CDF). I suspect that the species may be limited by some habitat requirement unrelated to foodplant. Certainly, this is a very local species. A larval description follows:

Last instar: Head and true legs, brownish red with darker shading. Cervical shield, nearly black with 12 minute white dots. Ground of body somewhat violet gray, strongly mottled with paler shades. Dorsal line, faint or absent. Subdorsal line represented by a conspicuous white dot in middle of all segments except first and last. Anterior to, and dorsal to these, a smaller white spot connected to subdorsal spot by a black patch, except on second and third segments. Lateral line, absent. Stigmatal line, very broad, white with definite blue tint, enclosing spiracles. Above and anterior to spiracles, a white dot with a black bar running to anterior edge of segment. Laterally, a conspicuous orange patch on each segment except first and last three. Anteriorly, ground shades into a dull, pale brown, partially obliterating pattern. Below stigmatal line, ground mottled with red, and with a white spot on most segments. Prolegs with a green patch.

Earlier instars: Head reddish, with darker patches. Anal segments enlarged, forming a hump, colored as rest of body. Body purplish, ventral surface not paler; subspiracular line very broad, cream color. Dorsal and subdorsal lines fine, cream. Pair of faintly darker patches centered about dorsal on each segment. Prolegs paler pinkish. This description, based on third and fourth instar larva. First instar is a semilooper as are most Noctuidae. The larva hides under debris in the later instars, at least in captivity. Unlike the Lithophanini, this species pupates in June and diapauses in that state.

CONCLUSION

The moths of this subfamily are primarily northern. Many do extend into the Delaware Valley region. Some extend much farther south. In general, they are less common in the southern parts of their range, although space did not allow for full discussion of this in the text. A few of the species are essentially southern. From what I have seen of southern collections there seems no doubt that these moths are poorly represented in that region and not merely overlooked. Several new life history data are presented here as well as new distributional data. I strongly suspect that more thorough collecting in the southern Appalachians will turn up many species, quite possibly some endemics. The Mt. Mitchell, North Carolina area seems especially promising. I hope that this paper will stimulate interest in these moths.

ACKNOWLEDGMENTS

I wish to thank the following persons for the use of their collections: Dr. A. E. Brower, Augusta, Maine; J. W. Cadbury III, Browns Mills,

New Jersey; Dr. R. B. Dominick, McClellanville, South Carolina; Joseph P. Muller, Lebanon, New Jersey; Eric L. Quinter, Auburn, Pennsylvania; J. B. Sullivan, Beaufort, North Carolina. Ric Peigler of Clemson University and Dr. F. Rindge of the American Museum of Natural History were helpful in arranging for me to examine those collections. Special thanks are due to Annie Carter of Batsto, New Jersey and to J. W. Cadbury III for their generous help in operating my traps, without which some of the records would not have been obtained. Dr. T. D. Sargent, University of Massachusetts generously supplied females from which ova were obtained and allowed me to collect extensively at his lights. An early draft of this report was submitted for credit in the Biology Department of St. Joseph's College, Philadelphia in May 1972 (Dr. R. W. Fredrickson, advisor).

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UNUSUAL AND INTERESTING BUTTERFLY RECORDS FROM TEXAS

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Increased collecting in southern Texas in recent years has resulted in a number of additions to our butterfly fauna. In addition, certain species formerly thought to be stragglers are now known to be of regular though perhaps infrequent or local occurrence. Others seem to be more or less cyclical, present in numbers in some years, scarce or absent in others. The activities of many workers are adding steadily to our formerly meager store of information about Texas butterflies.

I have reported on some species elsewhere (Tilden 1964; 1965a, b; 1971). Some of these notes were recorded on trips with my good friends Roy and Connie Kendall, to whom I am indebted for many favors. Collecting in the Santa Ana Wildlife Refuge (here shortened to Santa Ana WLR) was under permit from the U.S. Fish and Wildlife Service. All specimens leg. J. W. Tilden unless otherwise stated.

HESPERIIDAE

Nyctelius nyctelius (Latreille). CAMERON COUNTY: Brownsville, 3 ♂♂, 20 October 1972; 3 ♀♀, 29 October 1972; 1 ♂, 1 November 1972. Males worn. A powerful flier; perches on tips of shrubs in the open.

Panoquina sylvicola (Herrich-Schäffer). HIDALGO COUNTY: Santa Ana WLR, 1 ♂, 5 November 1972; 1 ♂, 7 November 1972; 1 ♀, 9 November 1972. CAMERON COUNTY: Brownsville, 1 ♀, 1 November 1972.

Panoquina hecebolus (Scudder). CAMERON COUNTY: Route 4, 6 miles west of Boca Chica, 1 ♀, 12 October 1971.

Panoquina evansi (Freeman). CAMERON COUNTY: Brownsville, 1 ♀, 20 October 1972. HIDALGO COUNTY: Santa Ana WLR, 1 ♂, 9 November 1972. The three I have taken have all been at flowers of *Eupatorium odoratum*, in partial shade.

Calpodex ethlius (Stoll). Usually frequents yards, feeding on *Canna*, but is found far afield occasionally. HIDALGO COUNTY: Santa Ana WLR, 2 ♂♂, 15–17 November 1970, in yard, at Papaya flowers; 1 ♀, 6 July 1972, on forest trail near Rio Grande. SAN PATRICIO COUNTY: Rob & Bessie Welder Wildlife Foundation Refuge, 1 ♂, on *Canna* in yard.

Yvretta carus (Edwards). JEFF DAVIS COUNTY: Wild Rose Pass, 1 ♀, 21 June 1963; 12 miles west of Alpine, 2 ♂♂, 1 ♀, 24 June 1963.

Ancyloxypha arene (Edwards). MAVERICK COUNTY: Quemado, 7 ♂♂, 3 ♀♀, all slightly worn. Associated with a wet grassy roadside hollow. Kendall (1966b) has shown that the related *A. numitor* feeds on a grass (*Zizaniopsis milacea*) which grows only in wet places. The habitat of *A. arene* suggests that it may have similar habits.

Cymaenes odilia trebius (Mabille). HIDALGO COUNTY: Fairly common in Santa Ana WLR, October–November 1970–72, on shady trails and at flowers of *Plumbago scandens* L.

Vidius perigenes (Godman). CAMERON COUNTY: 5 miles west of Boca Chica, 2 ♂♂, 1 ♀, 30 October 1970; Brownsville, 1 ♀, 19 October 1972. In nature, closely associated with a coarse bunch grass. Has been reared by Kendall (1966a) on the introduced St. Augustine Grass (*Stenotaphrum secundatum*).

Monca telata tyrtaeus (Plötz). HIDALGO COUNTY: Santa Ana WLR, common October–November 1970, less so in 1972, on trails and in forest openings, usually in deep shade.

Synapte malitiosa pecta Evans. HIDALGO COUNTY: Santa Ana WLR, common shady trails and openings, October–November 1970, much less so in 1972. Sits quietly on ground for long periods of time if not disturbed.

Pholisora alpheus (Edwards). CAMERON COUNTY: 4–6 miles west of Boca Chica on Route 4, 4 ♂♂, 1 ♀, 20 October 1963; 1 ♂, 1 ♀, 12 November 1963; 6 ♂♂, 2 ♀♀, 20 October 1970; 2 ♂♂, 1 ♀, 30 October 1970. The 1963 records seem to be the first for south coastal Texas. In 1972 the area was found to have been bulldozed and the colony destroyed.

Gesta gesta invisus (Butler & Druce). MAVERICK COUNTY: Quemado, 1 ♂, 8 October 1963, new county record. This species is more common on parts of the eastern coastal plain of Texas.

Chiomara asychis georgina (Reakirt). SAN PATRICIO COUNTY: Rob and Bessie Welder Wildlife Foundation Refuge, 1 ♂, 13 October 1963, new Refuge and county record. Fairly common in lower Rio Grande Valley, less common westerly but extends to Arizona.

Timochares ruptifasciatus (Plötz). CAMERON COUNTY: Brownsville, 1 ♂, 19 October 1972, on lower flowers of *Verbesina*.

Xenophanes trixus (Stoll). CAMERON COUNTY: Brownsville, a fair series, 20–31 October 1972. Very inconspicuous, sitting with wings spread, on lower leaves of *Verbesina* and *Eupatorium*.

Pellicia angra Evans. HIDALGO COUNTY: Santa Ana WLR, 1 ♂, 6 July 1972; 4 ♂♂, 6 ♀♀, 16 October–18 November 1972. May be confused with the much more common *Achlyodes thraso tamenund*.

Celaenorrhinus stallingsi Freeman. HIDALGO COUNTY: Santa Ana WLR, 1 ♂, 10 November 1972, taken among undergrowth in deep shade.

Cabares potillo (Lucas). CAMERON COUNTY: Brownsville, 1 ♀, 30 October 1963; Santa Maria, 1 ♂, 18 October 1972. HIDALGO COUNTY: Santa Ana WLR, 1 ♀, 21 October 1970; 1 ♀, 22 October 1970; 1 ♂, 27 October 1970; 1 ♂, 29 October 1970; 1 ♀, 4 November 1970; 1 ♀, 13 November 1970. Occasional but widely scattered; visits flowers of *Verbesina*, *Eupatorium*, and *Plumbago*.

Astrartes fulgurator azul (Reakirt). HIDALGO COUNTY: Santa Ana WLR, 1 ♂, 5 November 1970; 1 ♂, 16 October 1972; 1 ♀, 7 November 1972. Frequents shady, overgrown places.

Astrartes anaphus annetta Evans. CAMERON COUNTY: Brownsville, 1 ♂, 18 October 1972, at flowers of *Eupatorium odoratum* L.

Chioides zilpa (Butler). HIDALGO COUNTY: Sullivan City, 1 ♀, badly worn, at flowers of *Cordia boissieri* DC. (Anacahuite).

Phocides pygmalion lilea (Reakirt). CAMERON COUNTY: Brownsville, 4 ♂♂, 20 October 1972; 1 ♂, 1 ♀, 31 October 1972; others seen, too worn to take. HIDALGO COUNTY: Santa Ana WLR, 1 ♂, 17 October 1970.

PAPILIONIDAE

Papilio anchisiades idaeus Fabricius. HIDALGO COUNTY: Santa Ana WLR, 2 ♂♂, 19 October 1970, several worn individuals seen on other days. CAMERON COUNTY: Brownsville, 1 ♂, worn, 19 October 1972.

Papilio astyalus pallas Gray. HIDALGO COUNTY: Santa Ana WLR, 3 ♂♂, 17 October 1972; 1 ♂, 5 November 1972; 1 ♀ seen close-up, 7 July 1972. CAMERON COUNTY: Brownsville, several ♂♂, circa 9 October 1972, leg. Perry Glick, in his yard.

PIERIDAE

- Eurema दौरα lydia* (Felder & Felder). HIDALGO COUNTY: Santa Ana WLR, 1 ♂, 16 October 1972.
- Eurema boisduvaliana* (Felder & Felder). HIDALGO COUNTY: Santa Ana WLR, 1 ♂, 17 October 1970.
- Eurema nise nelphe* (R. Felder). Fairly common in the lower Rio Grande Valley along forest trails. Unlike *Eurema lisa*, seldom found in the open.

RIODINIDAE

- Lasaia sula peninsularis* Clench. Common in the lower Rio Grande Valley in October. Three specimens, 2 ♂♂, 1 ♀, 20–22 October 1963, are aberrant, having a complete row of marginal light spots on both upper and lower surfaces.
- Apodemia mormo mejicanus* (Behr). HUDSPETH COUNTY: near Sierra Blanca, 1 ♂, 2 ♀♀, 20 June 1963. PRESIDIO COUNTY: Shafter, 2 ♀♀, 7 October 1963.
- Apodemia palmerii* (Edwards). CULBERSON COUNTY: Van Horn, 1 ♀, 23 July 1967. JEFF DAVIS COUNTY: 12 miles west of Alpine, 1 ♀, 24 June 1963. PRESIDIO COUNTY: Shafter, 1 ♂, 7 October 1963.
- Apodemia walkeri* Godman & Salvin. CAMERON COUNTY: Brownsville, short series, both sexes, at flowers of *Serjania brachycarpa* Gray, 17–30 October 1963; Southmost, 1 ♀, worn, 29 October 1963.
- Apodemia multiplaga* Schaus. CAMERON COUNTY: Brownsville, 1 ♂, at flowers of *Serjania brachycarpa* Gray, 30 October 1963; 1 ♀, at flowers of *Verbesina*, 19 October 1972.
- Calephelis rawsoni* McAlpine. BEXAR COUNTY: FM 1604 at Babcock, 16 miles southwest of San Antonio, 1 ♂, 1 ♀, 11 October 1963. COMAL COUNTY: New Braunfels, 4 ♀♀, 27 October 1972. BREWSTER COUNTY: Boquillas Canyon, Big Bend National Park, 1 ♂, 1 ♀, 23 June 1963.

LYCAENIDAE

- Tmolus azia* (Hewitson). CAMERON COUNTY: 1 ♀, 29 October 1972, at flowers of *Serjania brachycarpa* Gray.
- Callophrys xami* (Reakirt). CAMERON COUNTY: 5 miles west of Boca Chica on Route 4, fairly common in October 1970. This area has been bulldozed and the colony destroyed or greatly reduced. HIDALGO COUNTY: Santa Ana WLR, 1 ♀, on a woodland trail!
- Callophrys goodsoni* (Clench). HIDALGO COUNTY: Santa Ana WLR, common in October 1970. Very scarce in October 1972, perhaps due to dry conditions; a single ♂, 5 November 1972.
- Strymon yojoa* (Reakirt). CAMERON COUNTY: Brownsville, 1 ♂, slightly worn, at flowers of *Eupatorium odoratum* L.
- Strymon albata sedacia* (Hewitson). HIDALGO COUNTY: Santa Ana WLR, 2 ♂♂, 7 November 1972, sitting on shrubbery, making short flights. See Kendall (1972).
- Strymon alea* (Hewitson). COMAL COUNTY: New Braunfels, 2 ♂♂, 27 October 1972. HIDALGO COUNTY: Santa Ana WLR, 1 ♀, 19 October 1972.

NYMPHALIDAE

- Apatura laure* (Drury). HIDALGO COUNTY: Santa Ana WLR, 1 ♂, 16 October 1972, sitting on *Celtis pallida* Torr. See Rickard (1969).
- Biblis hyperia aganisa* Boisduval. BEXAR COUNTY: San Antonio, 1 ♂, 7 October 1968, leg. William Tyson. CAMERON COUNTY: 3 miles east of Brownsville, 1 ♂, 30 October 1970.
- Dynamine dyonis* Geyer. CAMERON COUNTY: Brownsville, 1 ♀, 13 October 1963.
- Myscelia ethusa* Boisduval. HIDALGO COUNTY: Santa Ana WLR, fairly common along

- shaded trails under forest canopy; sits head down on tree trunks. CAMERON COUNTY: Brownsville, 1 ♂, 2 November 1972.
- Marpesia petreus* (Cramer). CAMERON COUNTY: Brownsville, 1 ♀, 1 November 1972, at flowers of *Eupatorium odoratum* L.; two others seen same day. Broken weather, with short showers.
- Limenitis archippus watsoni* (dos Passos). LIVE OAK COUNTY: North end of Lake Corpus Christi, 2 ♂♂, 1 ♀, 12 October 1963; 3 ♂♂, 2 ♀♀, 7 November 1963. Very similar to specimens from Louisiana.
- Metamorphia stelenes biplagiata* (Fruhstorfer). HIDALGO COUNTY: Occasional in Santa Ana WLR, usually badly worn; 2 nearly perfect ♂♂, 27 October 1970. CAMERON COUNTY: Santa Maria, 1 worn ♀, 18 October 1972; Brownsville, seen on three occasions in October 1972, all too worn to collect.
- Anartia fatima* (Fabricius). CAMERON COUNTY: Santa Maria, 2 ♂♂, 1 ♀, 18 October 1972; taken also by the Kendalls at the same time and place. HIDALGO COUNTY: Santa Ana WLR, 3 ♂♂, 4 July 1972; Bentsen-Rio Grande Valley State Park, 1 ♀, 5 July 1972.
- Junonia evarete* (Cramer). HIDALGO COUNTY: Santa Ana WLR, 1 ♂, 15 October 1970, leg. Wayne Shifflett. CAMERON COUNTY: Brownsville, 1 ♂, 21 October 1963. These may represent subspecies *zonalis* Felder & Felder. I have seen other specimens. Sympatric with *Junonia coenia* in the lower Rio Grande Valley.
- Junonia nigrosuffusa* Barnes & McDunnough. NUECES COUNTY: Mustang Island, 1 ♂, 15 October 1963; others seen. I have seen a number of specimens from coastal Texas, taken by others.

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BREEDING *HELICONIUS* (NYMPHALIDAE) IN A TEMPERATE CLIMATE¹

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Heliconius are among the most attractive of South American butterflies; they have beautiful bright color patterns, and their elongated wings enable them to perform quite remarkable tricks in flight, such as hovering, vertical climbs, and even flying backwards over short distances. Investigations on various aspects of their biology, reported in a wealth of papers, mainly in *Zoologica* and the *Journal of Insect Physiology*, have also made these animals into important research tools in such diverse fields as evolutionary genetics, ecology, behavior, and physiology. This is a brief account of the methods required to culture these organisms outside their normal tropical environment.

The methods described are those developed for genetical work on three species (*H. melpomene*, *H. erato* and *H. charitonia*) in England. Other species sometimes require rather more space, and, of course non-genetical work requires much less separation of females and therefore lends itself much more to mass culture. The results of the genetical experiments will be reported elsewhere (Sheppard and Turner, in prep.; Turner, 1973).

Techniques for culturing *Heliconius* in the tropics were developed under the guidance of William Beebe and Jocelyn Crane in Trinidad and have been described fully elsewhere (Crane & Fleming, 1953; Turner & Crane, 1962).

Culturing Adult Butterflies

Heliconius need to be kept at a temperature between 70°F and 105°F; below about 68°F they tend to become inactive (a slightly higher temperature for equatorial races, a slightly lower one for temperate races), but the night temperature when the butterflies are roosting can be brought as low as 60°F without obvious ill effects on the stock. Temperatures over 105°F become very dangerous after some time, particularly for butterflies which are already in a physiologically weakened condition, and in a changeable climate it is advisable to have thermostatically controlled windows as well as thermostatically controlled heating of the greenhouse.

¹ Dedicated to the memory of Roni Grainger.

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A greenhouse provides the simplest way of producing an agreeable environment for the butterflies, as it can be relied on to produce diurnal fluctuations in conditions without resort to the elaborate programming machinery required when using an enclosed artificial environment chamber. However, during the winter the surface of the glass becomes extremely cold and the butterflies must be kept off it, either by double glazing or by enclosing the butterflies in some kind of mesh cage within the greenhouse. The minimum size of cage in which the butterflies will breed normally and live out a reasonable span has not been accurately determined. Breeding experiments in York, England were conducted in walk-in cages about $9 \times 8 \times 7$ ft. and most forms did pretty well in these, although there was some obvious variation: the South Brazilian race of *H. erato* bred extremely well; the Amazonian race of *H. melpomene* bred well, although some individuals behaved as if they were a little unhappy in the confined space; hybrids between the South Brazilian and Amazonian races of *H. melpomene* spent excessive amounts of time on the roof of the cage and showed signs that a larger chamber might have served them better.

The London Zoo succeeded in breeding the Amazonian race of *H. melpomene* in a cage about $3 \times 3 \times 4$ ft., but this is probably only to be recommended when space is very short. With care it is also possible to breed from female butterflies kept in the sunny bay window of a sitting room with good background central heating, but only about one in five females takes to this life sufficiently to live more than a week or so, and to lay eggs.

Temperate variations in day length do not seem to upset the behavior of the butterflies unduly, nor does cloudy weather, with the exception of very thick cloud during the winter. On the whole roosting takes place at roughly the normal time of tropical sundown, but for cloudy weather it may be worth providing some artificial light in the form of strip lighting suspended over the cages. It is a mistake to place the lighting inside the cage as the butterflies tend to damage themselves by flying against the elaborate fittings.

Cages are best constructed from a bolted frame of pre-drilled angle iron, which is commercially available, covered with mosquito net or "Lumite" saran screening fixed on with a rubber adhesive. Sliding doors are quite easy to construct with such material, and should be no more than waist high, to reduce the possibility of butterflies escaping when the doors are opened; an extra curtain of netting hanging loose across the inside of the door is an added insurance. Butter muslin (cheesecloth) is not recommended for cages as it is difficult to see what is going on



Figs. 1-2. The *Heliconius* breeding-system used at the University of York: (1) the greenhouse. *Passiflora* plants to the left and upper right, a pair of cages to the right of the door. (2) a pair of cages in use. To the left inside the cage—*Passiflora serrato-digitata* and *Abutilon* sp.; in the background—*Passiflora caerulea*. The slits on the left and in the wall separating the two cages are for introducing plants on long canes. (Photographs by Richard Hunter.)

inside the cage, thus cutting down attention to emergencies, and polythene is likely to produce unfortunately stagnant conditions in the air in the cage. An alternative of course is to buy commercially manufactured cages. (For the use of a plastic netting tent, see the article by J. Brewer, *News of the Lepidopterists' Society*, 1972, number 6.)

Heating elements should be kept out of cages, as butterflies, particularly when sick, can destroy themselves by landing on them.

If humidifiers are not available, then high humidity may be maintained in the cages by frequent spraying of the floor with a hose. In a greenhouse with a concrete floor it pays to cover this with heavy duty polythene sheeting, as this collects puddles. To act as a more constant supply of humidity, particularly during hot weather, it helps to have a bed of saturated peat about six inches deep occupying about half the floor of each cage.

Heliconius butterflies take pollen in addition to nectar (Gilbert, 1972). Food sources are therefore a flowering plant which produces a plentiful supply of pollen (I have found *Abutilon* excellent for this purpose and readily obtained), and failing nectariferous flowers, a supply of honey. I have found it best to supply honey neat on the petals of a plastic flower, and also diluted in water in a dispenser of the type used for giving drinks to caged birds. It is also good to have a supply of pure water dispensed from a wet sponge, in addition to the supply of puddles on the floor. Because of the preferences for red or orange flowers shown by most *Heliconius* (Crane, 1955) it is good if sponges, plastic flowers and bird feeders are of one of these colors. In winter, honey can be changed once every two or three days, but in hot weather daily changes are needed, particularly of the honey-water mixture, to reduce the concentration of alcohol.

The cage should be supplied with additional plants to provide perching surfaces for the butterflies, and also shade; moving out of hot dry areas seems to be an important factor in the survival of the butterflies in the greenhouse during hot weather. *Grevillea robusta* is excellent for this purpose, and provides a photogenic background.

Culturing the Early Stages

Heliconius larvae feed on quite a wide variety of the five to six hundred species of *Passiflora* (see e.g. Alexander, 1961; Brown & Mielke, 1972). The three species used in the present experiment all laid and fed readily on *Passiflora caerulea*, which is a very vigorous grower and can be obtained easily from nurserymen in England (not in the USA), as it is a popular ornamental. Another good hardy species with large leaves,

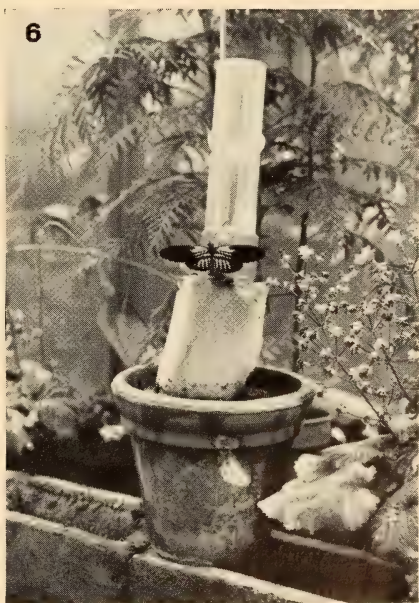
although a little slower growing, is the horticultural hybrid *P. allardi* (again unfortunately very rarely cultivated in America), which is eaten readily by *melpomene* and *erato* at least. In addition any of the tropical species which are natural foodplants (for example *P. laurifolia* and *P. serrato-digitata* for *melpomene*) may be used, but tend to be much slower growing and therefore harder to replenish. *P. biflora* makes a good foodplant for *erato*, but suffers badly from exposure to sun and low humidity.

Females lay regularly on the growing shoots of *Passiflora* vines placed in the cages. The simplest technique is to place a healthy young plant, potted and on a six foot cane, in the peat bed along with the other plants. The larvae can be left to feed on this plant, and require little attention, as cultures of these species outside the tropics seem to be relatively free of epidemic diseases. However, the larger larvae are prone to eat the young growing shoots of the plant; as these are the only sites used by the females for laying, they rapidly slow down the rate of egg production, as well as destroying any eggs and young larvae that are on the shoots when they are consumed. It therefore pays to move half-grown larvae by hand to the lower and older parts of the plant. With judicious transfers of larvae, three healthy *caerulea* can keep pace with the offspring of a normally fertile *Heliconius*, and thus provide one with continuous culture. For non-genetical work where the offspring of several females are mixed it is clearly necessary to provide more plants.

With an adequate food supply the larvae of the different species do not seem to compete excessively, and all can be cultured in the same cage. The larvae of *H. erato* and *H. charitonia* pupate on or near the plant on which they have fed and can safely be left to do so. *H. melpomene* larvae tend to wander between six and twelve feet before pupation (the warning sign of this is that they turn bright purple) and may thus get into the wrong cage, producing contamination of another brood. This is avoided by placing final instar larvae in standard cylindrical breeding cages (obtainable from English suppliers), to feed on cut vine stalks. The slow-growing but tough-leaved *P. laurifolia* is ideal for this purpose. The larvae will then pupate either on the gauze lid of the cylinder or on the cut stalks. Once all the larvae have pupated the stalks are placed vertically in the peat bed, and the butterflies allowed to eclose freely in the cage.

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Figs. 3-6. The *Heliconius* breeding-system used at the University of York: (3) To show the sliding door of the cage. On the left, *Passiflora serrato-digitata* and *P. auriculata*. (4) Inside the corner of a cage, showing the peat bed, polythene-covered



floor, butterfly-feeders, *Abutilon* (left), *Grevillea* (center), *P. caerulea* (foreground, mostly defoliated). (5) Transferring *Heliconius melpomene* larvae to a cylinder for pupation. Buckram cylinders behind. (6) An interracial hybrid of *Heliconius melpomene* feeding from a honey-water dispenser. (Photographs by Richard Hunter.)

Pupae which have become detached from their silk pad for any reason may be placed to eclose in the bottom of one of the larval breeding cylinders in which the plastic walls have been replaced by a cylinder of stout buckram, but this method results in the crippling of about one butterfly in five, when it fails to climb the buckram to blow out its wings. It is better, but more time consuming, to stick the cremaster of the pupa onto a woody branch, using a little clear rubber adhesive. This method has a high success-rate.

Eclosed offspring are collected and frozen once every one or two days, or transferred to other cages for breeding, or of course may be left in the cage for a continuing culture. The delay of a few days before males become fertile after eclosion gives one a little latitude in collecting them.

Butterflies are best transferred from cage to cage not in the hand, which may injure them, but in the small suspended gauze cages which breeders use for mating large silk moths.

When a female dies or is killed and her cage is required for another brood, the existing *Passiflora* plants can be covered completely with black organdie (organza) sleeves to separate the old brood from the new.

Envoy

Princes or professional researchers might seem to be the only people with the resources to grow these butterflies. Certainly genetical work requires a large amount of space because it is necessary to separate each female in a six foot or larger cage; in addition a considerable amount of greenhouse space is taken up with the stocks of *Passiflora* vines. But there is no reason why an amateur with a reasonably well appointed greenhouse, particularly in the warmer parts of the temperate zone, should not be able to cultivate these insects for fun. This they certainly provide.

ACKNOWLEDGMENTS

I am grateful to Miss Jocelyn Crane-Griffin, who instructed me in *Heliconius*-technique in Trinidad, and to Professor Philip M. Sheppard FRS, who originated several of the greenhouse techniques described here.

The detailed design of the cages, and their construction, was the work of the late Miss Veronica A. Grainger.

The work would not have gone forward without the expert attention given to the *Passiflora* plants by Mr. Colin Abbot and Mr. John Arber.

The final preparation of this paper was supported by a Biomedical Sciences Support Grant (HEW Grant #5S05 RR 07067) awarded to the State University of New York at Stony Brook and by NSF grant #B039300.

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OBSERVATIONS ON THE HABITAT OF
SATYRIUM KINGI (LYCAENIDAE)

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From my field observations during the past four years, along with data gathered from other sources, I have come to certain conclusions regarding the breeding habitats, flight habits and foodplants of *Satyrium kingi* (Klots & Clench).

I first collected *Satyrium kingi* in Escambia County, Florida, near Cantonment. It was a single worn female, taken 2 August 1969. I was not sure of its identification until I compared it with material I collected in South Carolina in 1970.

In addition to the Florida spot, I have taken *kingi* at four localities in South Carolina: (1) at Givhans Ferry State Park in Dorchester County; (2) on the south side of Highway 642 where Dorchester and Charleston Counties meet, about 200 yards inside Dorchester County; (3) in Berkeley County at the Naval Weapons Station, near the golf course; and (4) in Charleston County just outside the south gate of the Air Force Base along Dorchester Road.

These five localities can be divided into two types. One type, including the Florida locality and the two in Dorchester County, South Carolina, will be referred to as group A. The other two localities are called group B.

The group A localities are wooded areas, with few or no flowers at the time *kingi* was taken. Although I have not personally observed ovipositing in any of the 40 or so females I have collected, nor have any oviposited after capture, still it is my belief that sweet gum (*Liquidambar styraciflua*) will prove to be a primary foodplant of *S. kingi*. Ninety percent of the females which were not taken at flowers were collected from the leaves of sweet gum saplings. The other ten percent were on the leaves of various other plants near sweet gum.

In all the group A localities *kingi* was found around the edges of old forests where sweet gum saplings grew. I believe that much the same situation may exist with *S. kingi* as with *Papilio aristodemus ponceanus* (Schaus), where the species depends on second growth forests around older forests as its habitat (Rutkowski, 1971). Man's efforts may hurt *ponceanus* by overprotecting hammocks from natural disaster such as fire or storm, or by clearing hammocks away for construction, but his works may actually help *kingi* by cutting roads, making fire lines and power line cuts through old or virgin forests, thus providing areas for sweet gum saplings to grow.

I first found *kingi* in South Carolina at the Highway 642 locality in 1970. That season I collected some 15 females but only one male (on Holly (*Ilex*)) at that locality. During the 1971 season I again collected female *kingi* at this spot and also took a very few specimens from the Givhans Ferry State Park, type A locality, all females. In 1972 the Highway 642 locality again yielded several females but no males. By this time I had noticed the marked affinity the females had for sweet gum. So when I visited the Givhans Ferry State Park spot in 1972 I moved my collecting efforts 20 yards from where I had collected the year before and found female *kingi* in good numbers in a stand of sweet gum saplings. However, I had still not found any more males in the type A areas in three years!

In June 1972, at the Givhans Ferry State Park locality, I noticed a small butterfly come darting from high in the top of a mature sweet gum down to the young saplings where I was collecting female *kingi*, then return to the taller trees. A little later either the same specimen or another one did the same thing. However, before it could fly up again I netted it and found it was a male *kingi*. A little later I noticed two males dart down in this fashion from their lofty perches then fly up again

accompanied by females (this occurred at about 1630 EDT). I never saw a pair in copula, but did observe their courtship flights. Female *kingi* fly fairly low, from 4 to 10 ft. above the ground, around sweet gum saplings in the type A areas. Males stay high in older trees darting down to the saplings to look for females. After finding a female, the male accompanies her in a flight nearly straight up into the older trees.

The group B localities are open areas with tall flowering hedges. These flowering hedges were three to four hundred yards from any forests, but a limited number of *kingi* were taken there of both sexes. Obviously, they were there simply as flower visitors, and not because of any suitable breeding habitat. In the B areas, male and female *kingi* fly in more equal numbers, with males being slightly more numerous. Adults were never observed investigating each other or engaging in courtship flights. In 1971 and 72 twelve specimens were taken from the B areas, eight of which were males.

A significant distinction between the group A and B areas is that although both males and females were taken at group B spots, the vast majority of specimens taken from group A areas were females, with only two males collected there. The great contrast between the A and B areas leaves little doubt that *kingi* was in the B areas only to visit flowers. The absence of flowers in the A areas along with the large number of specimens, mostly females, found there year after year is strong evidence that *kingi* breeds in the A areas.

Even in the A areas, which seem to be the preferred natural breeding habitat, *kingi* is local in occurrence. It is found most commonly only where sweet gum saplings grow, and rests on the leaves of this plant. *S. kingi* shows such a marked affinity for sweet gum that this tree is presumably a foodplant. I have never found *kingi* in much searching in any other type of habitat, except when visiting flowers.

The place to look for *kingi* is around the edges of old, well established forests. These may be mixed hardwood and pine forests or hardwood alone. The butterfly may be found whether these forests are in low swampy areas or rather dry areas going into open pine flats and forest.

Males stay high in older trees, not always sweet gum, except when visiting flowers, at which time they are easily caught. Even when visiting flowers *kingi* males like the higher blossoms. Female *kingi* do not seem to visit flowers as much as males. Females should be looked for on sweet gum samplings usually only 5 to 6 ft. from the ground.

All five of the areas where I have collected *kingi* represent coastal populations. *Satyrrium kingi* was described in 1952 from the coastal population at Savannah, Georgia, by Klots and Clench. In the original description,

under the heading "Ecological Data," there are several items of interest. First, the Dorchester County locality in South Carolina can be described in almost the exact words used to describe the type locality (Klots & Clench, 1952, p. 15). Second, sweet gum (*Liquidambar styraciflua*) is noted as one of the plants found at the type locality. Third, as the collecting in the type locality was done while specimens were visiting flowers, more males should have been taken than females, and indeed the type series consisted of 5 males and 2 females, taken over a period of three years. It is also noted in the original description that specimens preferred the higher flowers they were visiting.

When describing *kingi*, Klots and Clench mentioned 5 specimens not included in the type series. These specimens were excluded from the type series "because of the danger of future subspecies confusion." Here in the original description a very important distinction is made between typical lowland (coastal) *kingi* and the inland or highland populations. (Klots & Clench, 1952, p. 8.) Klots and Clench saw the likelihood that northern inland populations of *kingi* might represent subspecifically distinct populations.

Mr. Lucien Harris Jr. in his recent book, "Butterflies of Georgia," stated that several years after *kingi* was described he too gave some thought to naming a subspecies from the inland areas of Georgia, but he decided to leave this to the "experts in this field."

If there is a subspecies involved in these highland populations the choice of foodplant is important. Because of this question, the relation of *S. kingi*, in my experience, to old forests and sweet gum, and its flower visiting and courtship flight habits, seem very relevant.

The northern (inland) population of *kingi* has been reared on Flame Azalea (*Rhododendron calendulaceum*) by Mr. John C. Symmes in the Atlanta, Georgia, area (Harris, 1972). Harris also notes that when H. L. King, for whom the species is named, collected *kingi* at the type locality he saw females ovipositing on a plant not related to Azalea, and that King did not find Azalea plants there. The ecological differentia between the lowland populations of *kingi* in Florida, Georgia and South Carolina, and those populations of inland and northern areas, along with the superficial differentia of those populations should be examined more closely by the experts, in my opinion.

Coastal *kingi* shares its habitat with a rather small number of butterflies. These species are rather uncommon and are usually considered good catches: *Autochton cellus* (Boisduval & Le Conte), *Poanes yehl* (Skinner), *Amblyscirtes aesculapius* (Fabricius), *Papilio palamedes* (Drury), *Satyrrium calanus* (Hübner), *Satyrrium liparops* (Le Conte),

Asterocampa alicia (Edwards) (following Reinthal, in Harris, 1972), *Asterocampa clyton* (Boisduval & Le Conte), *Lethe creola* (Skinner), *Lethe portlandia* (Fabricius), *Lethe appalachia* (Chermock), and *Euptychia gemma* (Hübner).

In the highland and inland areas *kingi* is on the wing in July and August. In the coastal areas of South Carolina and Georgia it flies in May and June. The late date of the one specimen I collected in coastal Florida (Aug. 2) may very well mean that *kingi* is double brooded there.

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NOTES AND NEWS

As a result of the recent election, it is a pleasure to announce that Norman D. Riley was overwhelmingly approved by the membership as an honorary life member of the Lepidopterists' Society. The newly elected officers of the Society are listed inside the front cover. In addition, Dr. W. Donald Duckworth was elected as the Jordan Medal Representative, and the proposed constitutional amendments (see Vol. 27, p. 241) were passed.

BUTTERFLIES OF SIX CENTRAL NEW MEXICO MOUNTAINS,
WITH NOTES ON *CALLOPHRYS* (*SANDIA*)
MACFARLANDI (LYCAENIDAE)

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Since 1964 I have resided in Albuquerque, New Mexico, and devoted much time to investigating the butterflies and moths of the surrounding mountains. The purpose of this article is to describe some of the observations made during these nine seasons.

Localities

Albuquerque itself is located a mile above sea level at the crossing of the Rio Grande Valley and U. S. Highway 66. The Valley is about 25 miles wide throughout this part of the state. About 75 miles north of Albuquerque, the New Mexican extensions of the high Colorado ranges begin dropping off into desert country. These northern mountains typically have 12,000–14,000 ft. peaks and 7000–8000 ft. valleys. However, the lower desert surrounding Albuquerque itself is only 4000–7000 ft. in elevation.

Scattered ranges rise from the desert at numerous points around Albuquerque (Fig. 1). These mountains are on both sides of the Rio Grande Valley, and have peaks of up to 11,000 ft. On the east side of Albuquerque, the **Sandia Mts.** begin at the edge of town; a bit southeast of Albuquerque, the **Manzano Mts.** begin. U. S. Highway 66 and Tijeras Canyon partially isolate the Sandias from the Manzanos. The bottom of the Albuquerque side of the Sandias and Manzanos is about 6000 ft. and fairly arid: about 8 in. of rain falls each year, mostly in the form of summer thundershowers. The bottom of these mountains on the side opposite Albuquerque averages 7500 ft., and is much more moist. Rainfall at the bottom on that side probably approaches 20 in. annually. To the east of the Sandias and Manzanos the Great Plains begin, and roll across the shallow Estancia and Pecos Valleys, gradually sloping down to 4000 ft. at the Texas state line. Peaks in the Sandias and the Manzanos are around 10,000 ft. The upper portions of both these ranges are heavily forested, but have Canadian zone meadows at the very summits.

To the west of the Rio Grande, the New Mexico desert rises gently up to 7000 ft. or 8000 ft. on the Continental Divide east of the Arizona line. In this area in the central latitudes of New Mexico, six or seven mountain ranges project above the desert to exceed 9000 ft.; the four easternmost are **Mt. Taylor**, **Ladron Peak**, the **Magdalena Mts.**, and the **San Mateo Mts.** The high desert west of Albuquerque is considerably drier than the Great Plains to the east.

Mt. Taylor is a fairly recent volcano of 11,000 ft. surrounded by a vast level plateau, especially to the northeast, which is uniformly just over 8000 ft. Most of this plateau is at least lightly forested. The top of Mt. Taylor proper breaks out into a large pseudo-arctic meadow of several square miles extent. Ladron Peak is a small, rugged monument which juts to just above 9000 ft. from the very low surrounding desert floor of 5000 ft. Ladron Peak is completely unforested, although the upper gorges with a northern exposure have scattered aspen (*Populus tremuloides* Michx.) and ponderosa (*Pinus ponderosa* Lawson). The Magdalena Mts. tend to resemble the Sandias and Manzanos, except that they run east-west instead of north-south and are Lower Sonoran rather than Upper Sonoran at the base. Large Canadian-

zone meadows also cover the tops of the Magdalenas, which reach nearly 11,000 ft. The San Mateo Mts. are isolated from the Magdalenas by the very arid Mulligan Valley and unpaved N. M. Route 107. They are less isolated from the Gila Mts. of southwestern New Mexico, at least in terms of possible dispersal routes not interrupted by broad, dry valleys.

Generally speaking, each range has been studied by intensive collecting for one season, preceded and followed by two seasons of occasional visitation.

The Colorado mountain extensions into northern New Mexico—the Jemez and Chuska on the west of the Rio Grande and the Sangre de Cristo on the east—have not been included in this work. I hope to examine these ranges in detail in future years. Also, the high Sacramento Mts. and the Guadalupe Ridge in southeastern New Mexico; and the Gila, Black Range, Animas, Zuni, and Datil mountains in the southwest are areas I want to probe eventually. Finally, the eastern plains and the Rio Grande riverbottom remain to be examined. (Obviously our very few resident New Mexican collectors will require quite a number of seasons to come to know a state nearly the size of California with a very complex life-zone pattern. For this reason, I would greatly appreciate correspondence with any outsiders who have done serious collecting here. Perhaps, with the help of outsiders, our study of the 12 previously-mentioned virgin areas can be greatly accelerated.)

RESULTS

Abundance Tabulation

My findings concerning occurrences and abundances of butterfly species in the six mountain ranges surrounding Albuquerque are summarized in Table 1. In this table, the following symbols and abbreviations are used:

TL—Mt. Taylor

SD—Sandia Mts.

MZ—Manzano Mts.

LD—Ladron Peak

MG—Magdalena Mts.

SM—San Mateo Mts.

A—abundant (over 100 per hour)

C—common (over 15 per year)

U—uncommon (2–15 per year)

S—single record

V—visual record

X—insufficient observation to distinguish between S, U or C

Q—record not observed by author

?—of uncertain determination or unknown collector

MT—Mike Toliver, collector

KR—Kilian Roever, collector

HK—Harry Clench, collector

JB—John Burns, collector

OS—Oakley Shields, collector

!—major range extension

(M)—migratory, either solitary or in numbers

(L)—intensely local

(D)—species often found on desert floor, away from mountains
and permanent water

Species numbers and names are as given by dos Passos (1964), except where revised: *Philotes* (Beuret, 1958) and (Langston, 1969); Melitacinae (dos Passos, 1969); *Vanessa* (Field, 1971); *Erynnis* (Burns, 1964); *Cercyonis* (Emmel, 1969); Theclinae (dos Passos, 1970); and Megathymidae (Freeman, 1969).

Correlation Coefficients of Species with Ranges

On the map (Fig. 1) and in Lines 1 of Table 2, correlation coefficients ρ_{jk} are shown of the species occurrence in the six ranges studied. These coefficients are computed by assigning a value X_{ij} of

1 to species i if it occurs in range j ,

0 to species i if it does not occur in j ,

and then calculating:

$$\rho_{jk} = \frac{\frac{1}{N} \sum_{i=1}^N (X_{ij} - n_j/N) (X_{ik} - n_k/N)}{\left[\frac{1}{N} \sum_{i=1}^N (X_{ij} - n_j/N)^2 \right]^{1/2} \left[\frac{1}{N} \sum_{i=1}^N (X_{ik} - n_k/N)^2 \right]^{1/2}}$$

Here, $n_j (= \sum_i X_{ij})$ and $n_k (= \sum_i X_{ik})$ are the total number of species occurring in ranges j and k , respectively, while N is the total number of species found in all six ranges. If ranges j and k have exactly the same species, ρ_{jk} would be 1. If all the species which occur in either range do not occur in the other, ρ_{jk} would be -1 . If one were to release in a room two live specimens of each of 100 species, and then permit two collectors to catch 100 random specimens each, ρ_{jk} between collectors j and k would be, on the average, 0. Thus, the ρ_{jk} are measures of the faunal similarities of the different ranges. The surprising aspect con-

TABLE 1. Abundances of butterflies in the six mountain ranges surrounding Albuquerque, New Mexico.

dos Passos Nos.	Butterflies	Mount Taylor (TL)	Sandia Mts. (SD)	Manzano Mts. (MZ)	Ladron Peak (LD)	Magdalena Mts. (MG)	San Mateo Mts. (SM)
MEGATHYMIDAE							
13d.	<i>Megathymus coloradensis coloradensis</i> (Riley) (D)		C	C	C		C
13f.	<i>Megathymus coloradensis navajo</i> Skinner	U _{MT}					
16.	<i>Megathymus streckeri</i> (Skinner)		U				
17b.	<i>Megathymus violae</i> Stallings & Turner			S _{HK} !			
HESPERIIDAE							
32.	<i>Amblyscirtes simius</i> Edwards		U				
33.	<i>Amblyscirtes cassus</i> Edwards			S!			S
34a.	<i>Amblyscirtes aenus aenus</i> Edwards		U _{KR}	C	C	C	U
35.	<i>Amblyscirtes osleri</i> (Skinner)			U			
36.	<i>Amblyscirtes fluonia</i> Codman			Q _{HK+JB}			C
44.	<i>Amblyscirtes eos</i> (Edwards)			S			
48.	<i>Amblyscirtes phylace</i> (Edwards)			C			
53.	<i>Atrytonopsis vierecki</i> (Skinner) (D)	S	C	C	C	C	C
56.	<i>Atrytonopsis pythou</i> (Edwards)		U	U	U	C	C
67a.	<i>Euphyes vestris vestris</i> (Boisduval)		C	C			
75.	<i>Poanes taxiles</i> (Edwards)	C	C	C	U	A	C
81.	<i>Ochlodes snowi</i> (Edwards)	C				U	
87.	<i>Atalopodes campestris</i> (Boisduval) (M,D)		C _{MT}		U		
93.	<i>Polites draco</i> (Edwards)					Q _{KR}	
100a.	<i>Hesperia uncas uncas</i> Edwards (D)	C	C	U	U	U	
108a.	<i>Hesperia pahaska pahaska</i> Leussler (D) ¹	C	C	C		U	S
109.	<i>Hesperia viridis</i> (Edwards) (D) ¹	C	C	C		U	

TABLE 1. (Continued)

dos Passos Nos.	Butterflies	Mount Taylor (TL)	Sandia Mis. (SD)	Manzano Mis. (MZ)	Ladron Peak (LD)	Magdalena Mis. (MG)	San Mateo Mis. (SM)
118.	<i>Stinga morrisoni</i> (Edwards)	C		C _{JB}		C	A
120.	<i>Yvretta rhesus</i> (Edwards)	U					
121.	<i>Yvretta carus</i> (Edwards)		U _{MT}				
122.	<i>Hylephila phyleus</i> (Drury) (M)		A _{MT}		U		
125.	<i>Copaodes aurantiaca</i> (Hewiston) (D)		S _{MT}		C	C	U
128.	<i>Oarisma garita</i> (Reakirt)	C		Q _{os}		C	
129.	<i>Oarisma edwardsii</i> (Barnes)	C		U		C	
144.	<i>Piruna pinus</i> (Edwards)		C	U		C	
148.	<i>Pholisora catullus</i> (Fabricius) (D) ¹				U	C	C
149.	<i>Pholisora meicana</i> (Reakirt) (D) ¹		C	C			
151.	<i>Pholisora alpheus</i> (Edwards) (D)	C	S	S	U	C	
152.	<i>Celotes nessus</i> (Edwards) (L)				C		
159.	<i>Pyrgus xanthus</i> Edwards						S
160.	<i>Pyrgus scriptura</i> (Boisduval)	U		S	U	S	U
161.	<i>Pyrgus communis</i> (Grote) (D)	C	C	C	C	C	A
163.	<i>Erynnis icelus</i> (Scudder & Burgess)			S			
164c.	<i>Erynnis brizo burgessi</i> (Skinner)	C	C	C	C	C	C
166b.	<i>Erynnis afranius</i> (Lintner) ²	C	C	C	C	C	C
168b.	<i>Erynnis funeralis</i> (Scudder & Burgess) (M)	S	U _{MT}	C	U	U	C
170.	<i>Erynnis pacuvius pacuvius</i> (Lintner)	U		U			U
172b.	<i>Erynnis tristis tatus</i> (Edwards)						U
173.	<i>Erynnis horatius</i> (Scudder & Burgess)		S	S	U		C
175½.	<i>Erynnis telemachus</i> Burns	C	C	C	C	C	C

TABLE 1. (Continued)

dos Passos Nos.	Butterflies	Mount Taylor (TL)	Sandia Mts. (SD)	Manzano Mts. (MZ)	Ladron Peak (LD)	Magdalena Mts. (MG)	San Mateo Mts. (SM)
187.	<i>Staphylus ceos</i> (Edwards)		Q ₂				
201.	<i>Thorybes pylades</i> (Scudder)	C	C	C		C	A
203c.	<i>Thorybes mexicana dobra</i> Evans		U _{MT}				
227.	<i>Zestusa dorus</i> (Edwards)		C	C		U	C
236b.	<i>Epargyreus clarus huachuca</i> (Dixon)		U _{MT}	C		C	U
PAPILIONIDAE							
246.	<i>Battus philenor</i> (Linnaeus) (M)	S	S _{MT}	V		U	S
248.	<i>Papilio polyxenes asterius</i> Stoll (D)		U	U	C	U	S
250.	<i>Papilio bairdii</i> Edwards	U		U	U		U
252.	<i>Papilio zelicaon</i> Lucas ³	C	U	U			
256.	<i>Papilio cressphontes cressphontes</i> Cramer (M)			S	V		
263.	<i>Papilio rutulus</i> Lucas	C	U	C		C	C
264.	<i>Papilio multicaudata</i> Kirby	C	C	C	C	C	
PIERIDAE							
272.	<i>Neophasia menapia menapia</i> (Felder & Felder)		U	C			U
276c.	<i>Pieris sisymbrii elicata</i> (Barnes & Benjamin)	U	C	U	U	C	C
277a.	<i>Pieris protodice</i> Boisduval & Le Conte (D)	C	C	C	C	C	C
277b.	<i>Pieris occidentalis</i> Reakirt (D)	X	X	S	C	C	C
278g.	<i>Pieris napi macdunnoughii</i> Remington		C				
280.	<i>Pieris rapae</i> (Linnaeus)		A _{MT}	U			S
286a.	<i>Colias euritheme</i> Boisduval		C	C	U	C	C
286c.	<i>Colias philodice eriphyle</i> Edwards	C			U		U
293.	<i>Colias alexandra</i> Edwards ssp.		U	C	U	U	

TABLE 1. (Continued)

dos Passos Nos.	Butterflies	Mount Taylor (TL)	Sandia Mts. (SD)	Manzano Mts. (MZ)	Ladron Peak (LD)	Magdalena Mts. (MG)	San Mateo Mts. (SM)
299.	<i>Colias cacesonia</i> (Stoll) (M)	V	U	C	C	C	U
302c.	<i>Phoebis sennae marcellina</i> (Cramer) (M)						U
312.	<i>Eurema mexicana</i> (Boisduval) (M)	U	SAR	C	C	C	
319.	<i>Eurema nicippe</i> (Cramer) (M)	U	C	C	C	C	C
320.	<i>Nathalis tole</i> Boisduval (M)	U	C	C	C	C	C
324f.	<i>Anthocartis sara inghami</i> Gunder	U	C	U	C	C	C
RIODINIADAE							
334.	<i>Apodemia normo</i> (Felder & Felder) ssp. (D)		C	U	C	C	U
335.	<i>Apodemia palmerii palmerii</i> (Edwards)				U!		
338.	<i>Apodemia nais</i> (Edwards)	U		U			
LYCAENIDAE							
350.	<i>Hypaurotis crysalus</i> (Edwards)		C	C		U	S
355.	<i>Harkenclenus titus mopsus</i> (Hübner)			U			
357b.	<i>Satyrium behrii crossi</i> (Field)		U	S!			
363c.	<i>Satyrium calanus godarti</i> (Field)		U				
389a.	<i>Callophrys (Incisalia) eryphon eryphon</i> (Boisduval)	U					Q _{KR}
390.	<i>Callophrys (Sandia) macfarlandi</i> Ehrlich & Glench ⁴		A	C	Cl	Cl	
395.	<i>Callophrys (Mitoura) spinetorum</i> (Hewiston)	C	C	C		U	C
396a.	<i>Callophrys (Mitoura) siva siva</i> (Edwards)	C	C	C	U	U	U
408a.	<i>Atides halesus halesus</i> (Cramer) (M)		U	U	S	U	C
417c.	<i>Strymon melinus franki</i> Field (D)	C	C	C	C	C	C
427.	<i>Erora quaderna sanfordi</i> dos Passos			S!		Cl	A

TABLE 1. (Continued)

dos Passos Nos.	Butterflies	Mount Taylor (TL)	Sandia Mts. (SD)	Manzano Mts. (MZ)	Ladron Peak (LD)	Magdalena Mts. (MG)	San Mateo Mts. (SM)
430d.	<i>Lycaena arota schellbachii</i> Tilden	U	C	C			
446.	<i>Brephidium exilis exilis</i> (Boisduval) (D)	C	C	U	C	U	C
449.	<i>Leptotes marina</i> (Reakirt) (D)	U	C	C	C	C	C
453b.	<i>Hemitarus isola alce</i> (Edwards) (D)	X	C	C	C	C	C
455a.	<i>Lycaeides melissa melissa</i> (Edwards)	C	U	C		C	U
458g.	<i>Plebejus icarioides lycea</i> (Edwards)	C					
462d.	<i>Plebejus acmon texanus</i> Goodpasture	S	C _{MT}	C	C	C	C
468e.	<i>Plebejus</i> (Agriades) <i>glandon rustica</i> (Edwards)	C	S	U!			C
470.	<i>Evers amyntula</i> (Boisduval) (D)	C	C	C		U	C
471d.	<i>Pseudophilotes battoides centralis</i> (Barnes & McDunnough) (L)	S	C	S		U	U
474a.	<i>Pseudophilotes rita rita</i> (Barnes & McDunnough)		C _{MT}		C _{MT}	U	C
475.	<i>Pseudophilotes spaldingi</i> (Barnes & McDunnough)			S!			
479.	<i>Glaucopsyche lygdamus oro</i> Scudder	C	U _{MT}	U			C
481f.	<i>Celastrina argiolus cinerea</i> (Edwards)	U	U	C	C	A	C
LIBYTHEIDAE							
482.	<i>Libytheana bachmanii</i> (Kirtland) (M,D)	S	U _{MT}	U			U
NYMPHALIDAE							
484.	<i>Anaea andria</i> Scudder (L)			U!			
492c.	<i>Asterocampa celtis antonia</i> (Edwards)		C				
492d.	<i>Asterocampa celtis montis</i> (Edwards) (L)				C	C	C
517b.	<i>Limenitis astyanax arizonensis</i> Edwards					U!	
518a.	<i>Limenitis archippus archippus</i> (Cramer)			C!			

TABLE 1. (Continued)

dos Passos Nos.	Butterflies	Mount Taylor (TL)	Sandia Mts. (SD)	Manzano Mts. (MZ)	Ladron Peak (LD)	Magdalena Mts. (MG)	San Mateo Mts. (SM)
519.	<i>Limenitis weidemeyerii weidemeyerii</i> Edwards	C ^o	C	C		C ^o	C ^o
522.	<i>Limenitis (Adelpha) bredowii eulalia</i> (Doubleday)	C	U	C	C	C	A
527.	<i>Vanessa atalanta rubria</i> (Frustorfer)	S	U	U	U	U	U
528.	<i>Cynthia virginensis</i> (Drury)	S	C	C	U	C	C
529.	<i>Cynthia cardui</i> (Linnaeus) (M,D)	C	A	A	C	C	A
530.	<i>Cynthia annabella</i> Field	U	U	U	S	C	S
531.	<i>Precis coenia</i> (Hübner)						S
534.	<i>Nymphalis californica californica</i> (Boisduval) (M)			S _{KR}			
535.	<i>Nymphalis milberti fuscillata</i> (Say)	U				S	
536.	<i>Nymphalis antiopa</i> (Linnaeus)	C	C	C	C	C	C
537.	<i>Polygonia interrogatoris</i> (Fabricius)		U _{MT}	Q _{KR}		V	
539.	<i>Polygonia satyrus</i> (Edwards)		U _{MT}	U _{KR}		U	C
543.	<i>Polygonia zephyrus</i> (Edwards)	C	C	C		C	C
551b.	<i>Chlosyne gabbii sabina</i> (Wright)					S	C
552.	<i>Chlosyne acastus</i> (Edwards)	U					
561.	<i>Chlosyne lacinia</i> (Geyer) (M) ⁷		S _{MT}		S	A	C
563.	<i>Phyciodes texana texana</i> (Edwards)			S	S		
566.	<i>Phyciodes tharos</i> (Drury) ssp.		U _{MT}	S _{KR}			
569b.	<i>Phyciodes campestris canillus</i> Edwards	C	C	C			S
570.	<i>Phyciodes picta canace</i> Edwards	C _{MT}	U		S _{MT}		
571.	<i>Phyciodes picta</i> (Edwards)				S!		
572.	<i>Phyciodes mylitta</i> (Edwards) ssp.	C	C	S _{KR} !	V	C	C
576.	<i>Thessalia alma</i> (Strecker)— <i>fulvia</i> (Edwards)		C	U _{MT}		C	
578.	<i>Dymasia dymas</i> (Edwards)				C _{MT} !	C!	C

TABLE 1. (Continued)

dos Passos Nos.	Butterflies	Mount Taylor (TL)	Sandia Mts. (SD)	Manzano Mts. (MZ)	Ladron Peak (LD)	Magdalena Mts. (MG)	San Mateo Mts. (SM)
582.	<i>Poladryas arachne</i> (Edwards)	S					U
618f.	<i>Speyeria atlantis dorothea</i> Moeck	C	C	C		C	A
624.	<i>Euptoiteta claudia</i> (Cramer) (M,D)	U	C	C	C	C	C
630b.	<i>Agraulis vanillae incarnata</i> (Riley) (M)		U _{MT}				
DANAIDAE							
631.	<i>Danaus plexippus plexippus</i> (Linnaeus) (M,D)	V	U	U	C	C	C
633b.	<i>Danaus gilippus strigosus</i> (Bates) (M,D)	U	U	U	C	C	C
SATYRIDAE							
640.	<i>Euptychia dorothea</i> (Nabakov)	U	C	C	C	C	A
647.	<i>Euptychia rubricata cheneyorum</i> R. L. Chermock					Cl	U
652.	<i>Coenonympha ochracea ochracea</i> Edwards			Cl			
655a.	<i>Neominois ridingsii ridingsii</i> (Edwards)	C					
656d.	<i>Cercyonis pegala boopis</i> (Behr)		C	C			
657.	<i>Cercyonis meadi meadi</i> (Edwards)		U	U	U	C	S
660.	<i>Cercyonis oetus charon</i> (Edwards)		C	C		A	C
665.	<i>Oeneis chryxus chryxus</i> (Doubleday)						Cl
"endemics"/total species ⁸		5/73	9/95	12/105	2/62	1/82	5/86

¹ determined by genitalia.² includes *persius* (Scudder).³ univoltine population.⁴ see appendix.⁵ occurs in Rio Grande Valley only; does not actually reach Manzano Mts.⁶ intergrades with *angustifascia* (Barnes & McDunnough) towards western part of study area.⁷ phenotypes of *adjutrix* Scudder and *crocale* (Edwards) occur together.⁸ an "endemic" is a species which has been found in only one range of the six.

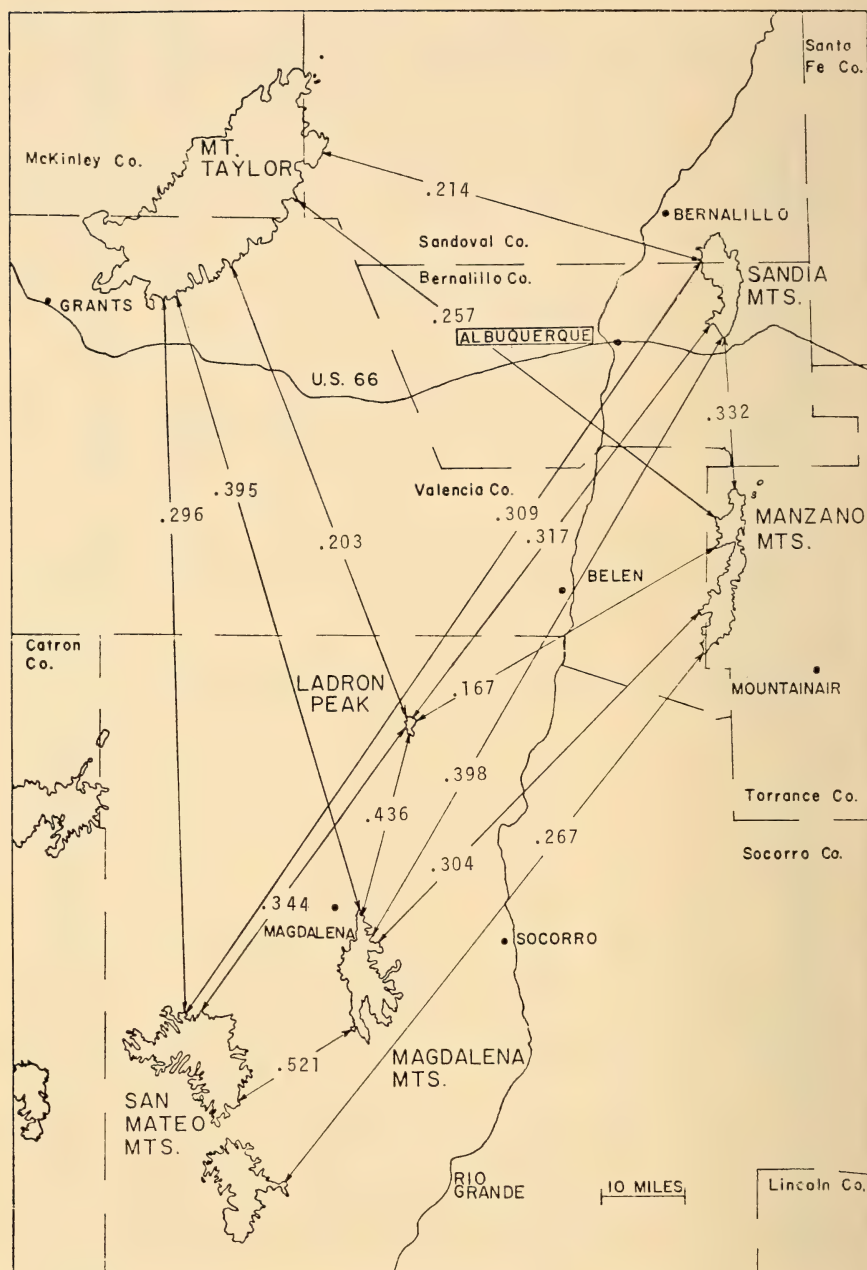


Fig. 1. Map of study area, showing mountain areas over 8000 ft. Numerical values indicate correlation coefficients of species occurrence.

cerning the species distribution correlation coefficients appearing on the map is their very low values. Even for the Sandias and the Manzanos, which are only 20 air miles apart with a 7000 ft. "bridge" connecting them, ρ_{jk} is just 0.3. This is about the correlation coefficient which relates the species of New York and South Carolina!

Several alternative procedures were also used for computing species distribution correlation coefficients. First of all, ρ_{jk} was re-evaluated by letting

- $X_{ij} = 4$ if species i is abundant (A) in range j ,
- 3 if species i is common (C) in range j ,
- 2 if species i is uncommon (U or X) in range j ,
- 1 if species i is of dubious occurrence (S, V, X, Q or ?) in range j ,
- 0 if species i is unreported from range j .

Lines 2 of Table 2 give the results of this computation. Next, ρ_{jk} was determined by the same process, but with X_{ij} reduced to 1 for all species indicated in Table 1 as showing tendencies to migrate or to reside on the desert. The effect of this modification on X_{ij} is to de-emphasize the occurrence of free-moving species in computing the correlation coefficients. Lines 3 of Table 2 show the values of ρ_{ij} found by this altered assignment of X_{ij} .

Additionally, ρ_{ij} was calculated with $X_{ij} = 0$ for all desert or migratory species. Here, the contribution of free-moving species is totally eliminated from the faunal similarity measurement. Lines 4 of Table 2 give these ρ_{ij} .

From the results shown in Lines 1-4 of Table 2, the following generalizations may be drawn:

a. Lines 4 are always greater than Lines 1-3. In statistical terminology, this means total suppression of frequency data on free-moving species gives the highest species distribution correlation coefficients. In other words, in comparing the characterizing fauna of isolated areas, it is best to ignore records of species which may frequently cross the isolating barriers. To do otherwise, at least on a sampling period of only nine years injects short-term dispersal effects. As these short-term effects are apparently fairly random, they cause the fauna of the various areas to appear more distinct than they truly are.

b. Lines 4 are always greater than Lines 3. Statistically, this means partial suppression of frequency data on free-moving species gives lower species correlations than total suppression of these data. In simpler language, if one wants to ignore effects of short-term dispersal in measuring faunal similarity, one should exclude totally the records of free-moving species. They should not be included with emphasis merely reduced.

TABLE 2. Correlation coefficients of butterfly species with mountain range.

	MT	SD	MZ	LP	MG	SM
MT		.214	.257	.203	.395	.296
		.253	.383	.162	.376	.310
		.233	.361	.112	.375	.348
		.356	.465	.233	.459	.448
		.761	.813	.656	.766	.656
SD			.332	.317	.398	.309
			.553	.357	.433	.340
			.554	.260	.493	.357
			.660	.381	.586	.481
			.880	.798	.747	.755
MZ				.167	.304	.267
				.282	.475	.423
				.204	.524	.448
				.353	.617	.563
				.768	.783	.778
LP					.436	.344
					.541	.447
					.460	.368
					.544	.472
					.862	.811
MG						.521
						.620
						.632
						.695
						.840

Lines 1: X_{ij} constrained to 1 or 0 for all species.

Lines 2: X_{ij} variable from 4 to 0 for all species.

Lines 3: X_{ij} constrained to 1 or 0 for desert-migratory species, otherwise variable from 4 to 0.

Lines 4: X_{ij} constrained to 0 for desert-migratory species, otherwise variable from 4 to 0.

Lines 5: X_{ij} variable from 4 to 0 for desert-migratory species, otherwise constrained to 0.

c. Lines 2 are usually greater than Lines 1. Mathematically, this means data on abundance of species in different areas will correlate more highly than a simple yes-no declaration as to occurrence of each species in each area. Ecologically, this is a rewording of the phenomenon that an organism which is common (successful) in one area is likely to be common in another area if it is found there at all.

d. Ladron Peak fauna correlates highly with only the Magdalena Mountains, although the converse is not true. Thus, Ladron Peak is biologically a depauperate island of the Magdalenas.

e. The Manzano Mts., which have the most "endemic" records, do not have noticeably low faunal correlations with the other ranges. A situation such as this may develop when foreign insects may drift into a new area more easily than they can drift out, or when an area has an unusually diverse foodplant flora relative to other areas in the study.

f. Early in this study, it was anticipated that more collecting in each range would raise the species distribution correlations. This anticipation seems not to have been borne out by annual re-evaluation of the correlations.

Correlation coefficients were also computed with data suppressed on desert species but not on migratory species. No unexpected trends appeared. Reversing desert and migratory species in this procedure also produced no surprises.

As a final computation, correlation coefficients were evaluated for the desert and migratory species only: the X_{ij} were reduced to zero for all other species. These values are given in the last lines of Table 2. In each range except Ladron Peak, about $\frac{1}{3}$ of the observed species are considered either desert or migratory. For Ladron Peak, the fraction is $\frac{1}{2}$. One can see that, as expected, free-moving species have much higher correlations than other species. This statement is, in fact, almost a tautology: Species which can readily cross barriers are more likely to turn up on both sides of the barriers than species which cannot.

SUMMARY

I have described briefly the topography of the area around Albuquerque, New Mexico, and presented a table which summarizes the occurrence and abundance of butterflies in six surrounding mountain ranges as observed over nine seasons. The data included in this table enable computation of species-distribution correlation coefficients between ranges. These coefficients are measures of the faunal similarities of the butterfly populations in the six ranges.

Appendix: Notes on *Callophrys* (*Sandia*) *macfarlandi*

Due to the considerable interest in this recently discovered "critter," the following previously unpublished records seem worthy of immediate dissemination. *Sandia macfarlandi* has now been recorded in New Mexico from: (a) virtually all points on the north, west, and south sides of the Sandia and Manzano Mts. between 5800 and 6400 ft. in Sandoval, Bernalillo, Valencia, Tarrant, and Socorro counties; (b) White Oaks and an adjacent colony about 10 miles to the southwest both in Lincoln County, and both around 5500 ft. (RH & MT); (c) Alamogordo Lake in De Baca

County, 4200 ft. (MT); (d) Conchas Lake State Park in San Miguel County, 4200 ft., and nearby in Guadalupe County on N. M. Route 129 (MT); (e) on the eastern side of the Sacramento Mts., near Hondo, Lincoln County (Bruce Harris); (f) on the western side of the Sacramento Mts., near High Rolls, 6000 ft., Otero County (RH & MT); (g) 3 miles west of Cimarron, 6500 ft., Colfax County (MT); (h) on all sides of Ladron Peak around 5800 ft., in Socorro County (RH); (i) on the northeast face of the Magdalena Mts., around 6000 ft., in Socorro County (RH); and (j) 1 mile NW of Acoma Pueblo, 5500 ft., Valencia County (RH). The last three of these records are the only known U. S. occurrences west of the Rio Grande. The foodplant of *macfarlandi*, *Nolina texana* Wats., does not seem to occur on Mt. Taylor or in the San Mateo Mts. Flight season in the Sandias has been found to extend from 15 February to 2 July. This makes *macfarlandi* the first non-hibernator to fly in the spring. Average annual temperature low in Albuquerque after 15 February is 10°F. Under proper conditions, *macfarlandi* is the most abundant butterfly in New Mexico. I have taken 42 with a single swing of a net at the composite *Senecio longilobus* Benth.

ACKNOWLEDGMENTS

Determinations of *Erynnis*, *Hesperia* and *Amblyscirtes* were made by Kilian Roever. John Lane first pointed out that the Sandia and Manzano *Pholisora* populations were not *catullus*. *Chlosyne* identifications were confirmed by Clifford D. Ferris. Countless hours of discussion about this article were spent with Mike Toliver, the only other long-term resident Albuquerque collector.

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FOODPLANT SPECIFICITY IN THE *PLEBEJUS*
(*ICARICIA*) *ACMON* GROUP (LYCAENIDAE)

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The *Plebejus acmon* group is composed of three closely related butterfly species: *P. acmon* (Westwood & Hewitson), *P. lupini* (Boisduval), and *P. neurona* (Skinner) (Goodpasture, 1973). These species comprise the *Eriogonum* (Polygonaceae)—feeding members of the subgenus *Icaricia*. *Plebejus acmon* ranges widely in western North America from the Pacific Coast west to the Great Plains, *P. lupini* occurs primarily in mountains of the Pacific Coast states, and *P. neurona* is restricted to elevations above about 5,000 ft. in central and southern California. Two subspecies of *P. lupini* are recognized; *l. lupini* occurring north of approximately 37° latitude, and *l. monticola* (Clemence) in southern and Baja California. Three subspecies of *P. acmon* are recognized; *a. acmon* in the southwestern region of the distribution of the species, *a. lutzi* dos Passos in the north, and *a. texanus* Goodpasture in the south. In California, where the distributions of the three species overlap, *P. acmon* is extensively sympatric with *P. lupini*, but *P. neurona*, tending to occur at higher elevations is only marginally sympatric with *P. lupini*.

The purpose of this investigation was to determine the relative degree of foodplant specificity among members of the *P. acmon* group. Data suggesting possible biological interactions between foodplant and both larval and adult butterflies are discussed.

Subspecific differences and interspecific variation in foodplant use were determined by direct observation in the field. The procedure established by Shields et al. (1970) for collecting and accurately reporting foodplant records was followed closely. Observations of larval feeding and adult oviposition are recorded in detail in an unpublished M.S. thesis (Goodpasture, 1971). Only a brief summary of foodplant records is given.

RESULTS

Larval foodplants of P. neurona. Comstock & Dammers (1933) briefly described the early stages of *P. neurona* and stated that this insect is found in association with *Eriogonum wrightii* Torr. Immature stages they described were reared on *E. fasciculatum* Benth. from, "Eggs secured from captive females taken at Blue Ridge, above Wrightwood, San Bernardino County on June 8, 1932" (Comstock & Dammers, 1933).

Subsequent oviposition records and field observations have confirmed this association and indicate a definite preference for leaves as oviposition sites. Laboratory rearing of adults has been carried out on *E. w.* var. *subscaposum* (Wats.) from eggs and first instar larvae found on leaves of this plant.

Foodplant acceptance tests have shown that *P. neurona* cannot complete development on legume plant species that are acceptable to larvae of *P. acmon acmon* (Goodpasture, 1971).

Evidence of foodplant specificity was obtained from field observations made near Mt. Hillyer, Angeles National Forest, Los Angeles Co., California, elev. 6,000 ft. At this locality, a number of plants of several abundant *Eriogonum* species were found within a radius of 100 feet. *Plebejus neurona* was the only abundant¹ *Icaricia* species encountered here during June and July 1969 and 1970 when a systematic search was made of the following *Eriogonum* species at this locality: *wrightii* var. *subscaposum*, *nudum* var. *publiflorum* Benth., *davidsonii* Greene, and *umbellatum* Torr. ssp. A total of 17 eggs, microscopically identical to eggs obtained from captive female *P. neurona*, were found on *E. wrightii* var. *subscaposum*, while none were located on the other species of *Eriogonum*.

Two often sympatric varieties of *E. wrightii* occur throughout the range of *P. neurona*: *E. w. subscaposum* in the San Bernardino Mountains north into the Sierra Nevada, and *E. w. trachygonum* (Torr. ex Benth.) from northern Los Angeles County to the base of the Sierra Nevada (Munz, 1968). Foodplant records and field observations indicate that *P. neurona* is restricted to these low, matted shrubs in montane coniferous forest associations.

Larval foodplants of P. acmon acmon. Documented records indicate that *P. acmon acmon* feeds on more species of plants than any other group member and that it is the only subspecies to utilize legumes as well as plants of the family Polygonaceae.

Localities where observation of utilization of more than one plant family as foodplant and or oviposition site have been made are: Monticello Dam, Napa Co. [*Lotus scoparius* (Nutt.) Ottley, *L. purshianus* (Benth.), and *Eriogonum nudum* (Dougl. ex Benth.)], Frazier Park, Kern Co. [*L. procumbens* (Greene) Greene, and *Eriogonum* sp. (probably *nudum* or *elongatum* Benth.)], and Laguna Grade, San Diego Co. [*Lotus* sp. and *E. wrightii* var. *membranaceum* Stokes ex Jeps]. At localities near Davis, Yolo Co., several foodplants such as *L. purshianus* and

¹ *Plebejus* (*Icaricia*) *icarioides* (Bdv.) and *P. acmon acmon* were common at localities within at least 1 mi. of the Mt. Hillyer locality, yet none were taken here during the course of this study probably due to the absence of appropriate legume foodplants in the immediate Mt. Hillyer area.

Polygonum aviculae L., an introduced weed, co-occur with *P. acmon acmon* and are probably utilized simultaneously. At all other localities records are available for only one plant species and it is not known if these populations are actually or potentially polyphagous.

At localities such as Monticello Dam where adult flight period extends from spring to late summer, suitable foodplants appear to be used sequentially according to their seasonal availability. Records from the central Coast Ranges in California for *Lotus scoparius*: 7 March–9 May; *E. latifolium-nudum*: 19 February–15 May (leaves), 3–15 August (flowers); and *L. purshianus*: 21 May–6 September, coincide with seasonal availability of these plants. Gorelick (1969) has suggested sequential utilization of *E. latifolium* Sm. in Rees. in the San Bruno Mountains, San Mateo Co., with the larvae feeding on leaves in spring prior to early summer die-back, and on flowers as they become available to successive generations during later months. At Monticello Dam, larvae were found to move from drying flower heads of *E. nudum* during late summer to overwintering sites in leaf litter at the base of these plants. At other localities, only a single suitable plant species may occur as at Putah Creek, U.C.D. campus, Yolo Co., where the only foodplant is the annual *L. purshianus*. *Plebejus acmon acmon* adults are not found at this locality until June (based on two years observation and museum specimens), when plants are well established. Seed germination of *L. purshianus* begins very early in winter, with the result that by March there are numerous new shoots about four inches long growing under dense winter annual vegetation. Progeny of females collected at Monticello Dam from March through August and at Putah Creek from June through mid-September do not enter diapause when reared under laboratory conditions of constant temperature and naturally occurring daylength. It is assumed that both populations are multivoltine. Individuals from these two populations respond similarly to decreasing photoperiod and enter diapause in late summer as early instar larvae (Goodpasture, 1973). Seasonal flight data indicate that these populations differ markedly in response to conditions initiating breaking of diapause. Termination of diapause in winter at Putah Creek would seem disadvantageous if foodplant is available only in summer months. Termination of diapause in winter (December?) at Monticello Dam would allow earlier activity of adults and might be advantageous where a polyphagous population feeds on plants available at different times of the year.

A number of plants not known to be fed upon by wild *P. acmon* larvae have been found to be acceptable as laboratory foodplants. These plants are *Lotus corniculatus* L., *Lupinus albifrons* Benth., *Eriogonum fascicu-*

latum, and *E. umbellatum* (Goodpasture, 1971). In addition, flowers of *Trifolium obtusiflorum* Hook. were reported by Gorelick (1969) to be acceptable as larval foodplant. These plants are available to females of *P. acmon acmon* at various localities but are apparently not selected for oviposition and are probably not utilized as food. *Eriogonum fasciculatum*, for example, is coextensive with *P. acmon acmon* in southern California, but appears not to be used as food.

At many localities the shrub-like *E. fasciculatum* occurs and other, usually herbaceous species of *Eriogonum* and/or legumes are used as foodplants. For example, at Del Puerto Canyon, Stanislaus Co., and Frazier Park, *E. nudum* is the only known foodplant. Field observations of foodplant utilization, and adult flight period, and *Eriogonum* ecology, show that at these localities *E. fasciculatum* is potentially available to larvae and ovipositing females from March or April through June. At other localities such as Switzer's Camp, Los Angeles Co., and Laguna Grade, adult flight season extends from June through September or October when *E. fasciculatum* is probably not suitable as larval foodplant due to cessation of vegetative growth of this plant during summer drought.

Preference for oviposition on certain plant parts may exist in some populations. At some localities, oviposition has been observed on all plant parts (*Lotus*, Switzer's Camp and Putah Creek), exclusively on leaves (*Eriogonum wrightii*, Laguna Grade), or exclusively on flowers (*E. elongatum*, Hidden Valley and Lake Sherwood, Ventura Co.). Where *Eriogonum* species are utilized as foodplant, eggs might be placed on floral or leaf structures depending on seasonal availability or suitability of plant material.

In conclusion, the foodplants of *P. acmon acmon* in California are plants of the families Leguminosae and Polygonaceae. As can be seen in Fig. 1, the perennial herbaceous *Eriogonum* species *latifolium*, *nudum*, and *elongatum*, as well as certain legumes (*Lotus scoparius* and *L. purshianus*), are the most frequently encountered foodplants. In southern California, *Lotus* species may serve as the primary food source, with several additional *Eriogonum* species of rather limited distribution (e.g. *E. parvifolium* Sm. in Rees. and *E. plumatella* Dur. & Hilg.) as occasional foodplants.

Larval foodplants of P. acmon lutzi and P. acmon texanus. Foodplants of *P. acmon* occurring outside of California are poorly known. Available records are primarily associational and indicate that various *Eriogonum* species are utilized as foodplants.

Association of adults of *P. acmon lutzi* with *E. marifolium* T. & G. and

E. pyroliifolium Hook at Mt. Bachelor, Oregon suggests use of these plants. Adults of *P. a. lutzi* form *spangelatus* have been reared from larvae collected on an unidentified *Eriogonum* species, Olympic Mountains National Park, Washington (J. Pelham, pers. comm.). Foodplant records for Wyoming include *E. flavum* Nutt. and *E. umbellatum* (C. D. Ferris, pers. comm.).

Observations of oviposition and co-occurrence of adults and plants suggest that *P. acmon texanus* feeds on *E. wrightii* var. *wrightii* at localities in Arizona, New Mexico, and Texas, and that *E. corymbosum* var. *velututinum* Reveal & Brotherson is a foodplant near Cerrillos, New Mexico. Oviposition records, as well as associational data, indicate that *E. effusum* Nutt. and *E. racemosum* Nutt. are utilized at several Colorado localities.

Larval foodplants of P. lupini lupini. Several shrub-like *Eriogonum* species are documented as larval foodplants of *P. lupini lupini*. In California, *E. umbellatum* and *E. ovalifolium* Nutt. are the only known foodplants. Emmel & Emmel (1962); and Garth & Tilden (1963) have noted adult association with *Eriogonum* at Donner Pass and in Yosemite National Park. It appears from available records, that *E. umbellatum* is the primary food source in the Sierra Nevada and the north Coast Ranges at least in California. In Nevada, a wider variety of *Eriogonum* species may be utilized. Records from mountainous areas in central Nevada indicate use of *E. kearneyi* Tidestr., *E. ovalifolium*, *E. palmerianum* Reveal, and *E. umbellatum*. Statements that *Lupinus* spp. are utilized (Boisduval, 1869, ". . . dans le sud de la Californie."; Jones, 1951, Washington) are without supporting data.

Field observations made at Echo Lake, El Dorado Co., suggest that flowers of *E. umbellatum* var. *umbellatum* are preferred as an ovipositional site. Seven females seen ovipositing at this locality (13–19 July 1970) laid a total of 17 eggs, 15 on flowers and two on leaves. Females were not seen to oviposit on other *Eriogonum* species (*nudum*, *incanum* Torr. & Gray, *lobii* Torr. & Gray, and *wrightii*) also present at this locality.

Plebejus lupini appears most similar to *P. neurona* in terms of larval acceptance and the nutritional adequacy of several plants, as well as in preferences inferred from field data. Larvae of these two species accept flowers of *Lotus corniculatus* but develop poorly and suffer high mortality, whereas *P. acmon acmon* larvae show no mortality on this plant (Goodpasture, 1971).

Larval foodplants of P. lupini monticola. Foodplant records from eight localities suggest that *P. lupini monticola* is restricted to *E. fasciculatum*

Foodplant	<i>P. neurona</i>	<i>P. acmon acmon</i>	<i>P. acmon lutzii</i>	<i>P. acmon texanus</i>	<i>P. lupini lupini</i>	<i>P. lupini monticola</i>
POLYGONACEAE						
<i>Polygonum aviculae</i> -----	D2					
<i>Eriogonum corymbosum</i> -----		S1				
<i>effusum</i> -----			D2			
<i>elongatum</i> -----	D2					
<i>fasciculatum</i> -----						D7
<i>kearneyi</i> -----					D1	
<i>latifolium</i> & <i>nudum</i> -----	D9					
<i>marifolium</i> & <i>pyrolifolium</i> --		S1				
<i>ovalifolium</i> -----					D1	
<i>palmerianum</i> -----					D1	
<i>parvifolium</i> -----	D1					
<i>plumatella</i> -----	D1					
<i>racemosum</i> -----				D1		
<i>umbellatum</i> -----			D1		D6	
<i>umbellatum</i> ssp. -----						D1
<i>wrightii wrightii</i> -----				D,S 4		
<i>w. subscaposum</i> & -----	D5					
<i>w. trachygonum</i>						
LEGUMINOSAE						
<i>Lotus</i> & <i>Astragalus</i> -----		D13				

Fig. 1. Summary of foodplant records for the *Plebejus acmon* group. Documented records (D) = larval rearing to adult, oviposition observed. Suspected foodplants (S) = adults collected in association with plant, pre-oviposition behavior observed. Numerals refer to number of localities (more than 10 miles apart) where observations of foodplant use have been made.

in most of its range throughout chapparral communities in the southern half of California. Utilization of more than one species of *Eriogonum* may occur at Laguna Grade, where females have been observed to oviposit on *E. wrightii* var. *membranaceum* as well as on *E. f.* var. *polifolium* (Benth.). At this locality, near the upper altitudinal limit of *E. fasciculatum*, *E. w.* var. *membranaceum* is the more common plant,

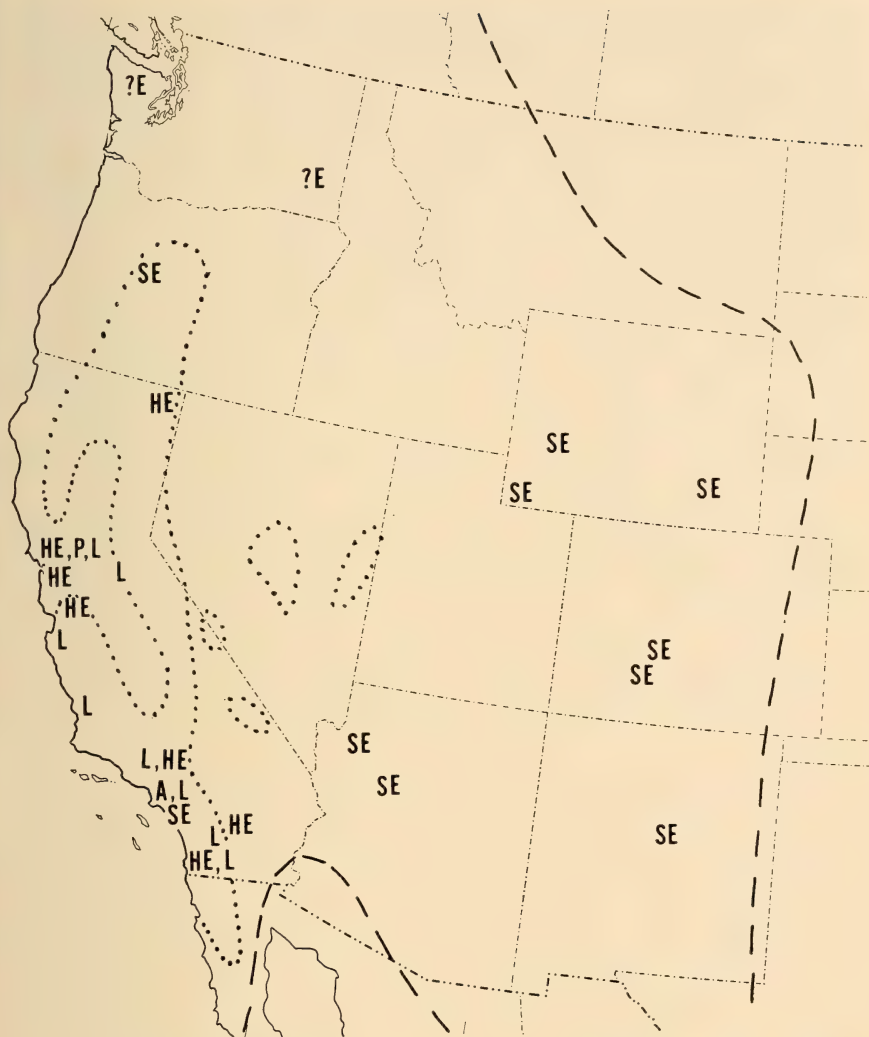


Fig. 2. Geographical distribution of foodplant specificity in *Plebejus acmon*. Dashed line represents approximate known distribution of *P. acmon*. Dotted line represents distribution of *P. lupini* and area of *P. acmon*-*P. lupini* sympatry. *P. lupini* foodplants are shrub-like *Eriogonum* species throughout its range. A = *Astragalus*, L = *Lupinus*, P = *Polygonum*, HE = herbaceous *Eriogonum*, SE = shrub-like *Eriogonum* species. Herbaceous *Eriogonum* species include *elongatum*, *latifolium*, and *nudum*. Other species of *Eriogonum* mentioned in the text are considered shrub-like (Munz, 1968).

and appears to be the principal foodplant. Oviposition by a single female has been observed on *E. umbellatum* subsp. at Horse Thief Springs, San Bernardino Co. Other *Eriogonum* species present at this locality include *fasciculatum*, *wrightii*, and *heermannii* Dur. & Hilg. (A. O. Shields, pers. comm.) and may also be utilized by *P. lupini monticola*.

Observations of oviposition behavior and placement of field collected eggs indicate that floral structures are preferred over leaves as oviposition sites when both are available (Goodpasture, 1971).

Geographical distribution of foodplant specificity. Fig. 1 illustrates that members of the *Plebejus acmon* group tend to have mutually exclusive diets. This is especially evident in California where distributions of four of these entities overlap. *Plebejus neurona*, *P. lupini monticola*, and *P. lupini lupini* have no foodplants in common at the varietal level and are narrowly oligophagous, feeding predominantly on a single species or subspecies of *Eriogonum*. Outside of California, at least in central Nevada, *P. lupini* apparently utilizes a much wider variety of *Eriogonum* foodplants. As can be seen in Fig. 2, polyphagy in *P. acmon* shows some correlation with geography and distribution of *P. lupini*. Thus, *P. acmon* feeds on *Astragalus* (A), *Lotus* (L), *Polygonum* (P), herbaceous (HE), and shrub-like *Eriogonum* (SE) species only in California where it is broadly sympatric with *P. lupini*. Outside of California, *P. acmon* is known to utilize only shrub-like *Eriogonum* species.

DISCUSSION

Larval choice of foodplant in Lepidoptera may be requisite for survival in species with a larval dispersal stage or with larvae defoliating part of their available food supply (Dethier, 1959; Cook, 1961). Larval ability to select proper plant species may also play a role in foodplant relationships in this *Plebejus* group where larvae overwinter as early instars. For example, *P. acmon acmon* terminating diapause in May at Putah Creek must locate early season growth of the annual *Lotus purshianus*. Larvae terminating diapause at localities where annual foodplants are utilized may encounter and accept plant species other than those upon which eggs were laid during the previous growing season. The probability of larvae encountering foodplants of the same species as chosen by females of the final summer generation may depend on such factors as success of seedling establishment in annual plants or the number of acceptable alternative plants growing in close proximity to overwintering larvae.

Larval acceptance tests have demonstrated that larvae from several populations of several subspecies of the *P. acmon* group accept many plant species not known to be utilized in nature. While these potential

foodplants elicit and sustain, or at least do not deter, larval feeding, full suitability² remains uncertain because fertility of reared adults has not been tested. It is assumed from larval acceptance of various plants, as well as from knowledge of plant distributions, that a large number of *Eriogonum* species are available and suitable to many populations of all group entities. At least some populations of *P. lupini* and *P. neurona* feed on only one of several species of *Eriogonum* growing at one locality. A similar pattern of food resource utilization may exist throughout the *Icaricia*. It has been shown that larvae of *P. icarioides* will feed on any species of *Lupinus* in captivity, but wild populations normally utilize only a few of the possible range of *Lupinus* species growing locally (Downey & Fuller, 1961; Downey, 1962).

Rigid specificity encountered in nature in most members of this group seems to be due primarily to the precision with which females lay their eggs on certain plants, as has been stressed by Merz (1959) for several other Lepidoptera. In field studies, both *P. neurona* and *P. lupini lupini* were found to display a high degree of foodplant specificity. Presumably, females respond to specific plant stimuli in selecting a single *Eriogonum* species for oviposition from among several available at a single locality.

Many populations of the *P. acmon* group differ in both plant species and complement of species utilized for food. Although this may be the result of coincidence of plant distribution, larvae and ovipositing females may have different preferences at different localities. It should be noted that the extent to which differences in foodplant use reflect differences in foodplant preference is unknown in this group.

Failure of *P. acmon* members to utilize certain potential foodplant species during certain times of the year, e.g. *E. fasciculatum* by *P. acmon acmon* during summer months, may be due to unsuitability caused by drying and hardening of leaves and flowers. Although females of at least some *P. acmon acmon* populations will lay eggs on *E. fasciculatum* var. *foliolosum* in captivity, larvae are not able to survive on this plant when hatching from eggs laid during and after June (Goodpasture, 1971). Cole (1967) has shown that shoot growth of several *Eriogonum* species, including *E. fasciculatum*, ceases in May in the Santa Monica Mountains and that dramatic changes in leaf physiology accompany soil drought in summer months.

Differences in feeding preferences within and between closely related species may provide information on evolutionary mechanisms that can

² Remington & Pease (1955) define the test of full suitability of a plant in terms of larval rearing to adult solely on that plant with the production of adults which, when induced to mate, lay eggs which then hatch.

account for changes between polyphagy and monophagy (Dethier, 1954). For example, within this group spatial and temporal differences in foodplant utilization may have evolved independently in isolation or as a result of competition resulting in ecological character displacement. The data available do not allow distinction between these alternatives. However, evidence seemingly in support of competitive displacement is: (1) different sympatric subspecies of this group tend to have mutually exclusive foodplants; (2) *P. acmon* does not utilize shrub-like *Eriogonum* species where it is sympatric with *P. lupini*, and feeds on a wide variety of shrub-like *Eriogonum* species where it is widely allopatric to *P. lupini*; and (3) *P. acmon* is morphologically distinct from *P. lupini* where these two species are sympatric, and convergent to *P. lupini* where it occurs in states widely allopatric to the distribution of *P. lupini* (Goodpasture, 1973).

Dethier (1954) has also suggested that polyphagy is the more primitive condition in phytophagous insects. This may also apply to the *P. acmon* group. Oligophagy and *Eriogonum* feeding as exemplified by the narrow feeding habits of *P. neurona* may have been derived from a polyphagous ancestor with food habits similar to those of *P. acmon acmon*.

SUMMARY

Data on foodplants use by members of the *Plebejus acmon* group are summarized in Fig. 1. *Plebejus acmon acmon* is the only polyphagous group member, feeding on the legumes *Lotus* and *Astragalus* as well as the Polygonaceae *Eriogonum* and *Polygonum*. All other group members are oligophagous and restricted to feeding on one or a few species of *Eriogonum*. Members of this group tend to have mutually exclusive diets.

Differences in foodplant use between species and subspecies of this group are discussed in terms of foodplant ecology, geographical distribution of foodplant specificity, and possible larval feeding and adult oviposition preferences.

ACKNOWLEDGMENTS

Many of the foodplant records used in this study were collected by Oakley Shields (University of California at Davis) and John Emmel (Santa Monica, California), and their assistance is gratefully acknowledged. Acknowledgment is also due Chris Henne (Pearblossom, California), Paul Opler, James Scott, John Shepard (formerly University of California at Berkeley), R. F. Denno, A. M. Shapiro (University of California, Davis), C. D. Ferris (University of Wyoming), and John Lane (California State University at Northridge) for providing valuable field data and making collections available for study.

Numerous plant determinations were kindly made by Dr. J. L. Reveal (University of Maryland) for *Eriogonum*, B. J. McCaskill (University of California, Davis), and R. Gustafson (Los Angeles County Museum of Natural History).

For their aid in discussion and constructive criticism throughout this study I am indebted to Drs. R. W. Thorp, R. M. Bohart, L. D. Gottlieb, and Mr. Oakley Shields.

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POPULATION BIOLOGY AND ADULT BEHAVIOR OF
LYCAENA AROTA (LYCAENIDAE)

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The purpose of this paper is to describe adult behavior (mate-locating, mating, feeding, oviposition, and basking), dispersal, and population parameters (especially lifespan) of *L. arota* Boisduval.

A mark-recapture study was conducted in 1969 at the mouth of Rouch Gulch (Spring Creek), Fremont County, Colorado. *L. arota* was also studied in 1971 one km east of Smith Creek Campground, Custer County, Colorado, and at Little Fountain Creek, El Paso County, Colorado. These sites were mountain gulches or streams with abundant larval host, *Ribes* spp.

METHODS

Number of matings per female was determined by counting spermatophores (Burns, 1968). For study of movements and estimation of population parameters, butterflies were marked individually using the method of Ehrlich & Davidson (1960). They were captured with a net, marked, and immediately released at the site of capture.

Analysis of population movements. The following method allows direct comparison between the sexes and between species, determination of change of movements with age, and separation of the velocity and distance aspects of movements. On a map of the movements of each recaptured individual, distances in mm between each two captures are measured, and called d_1 between first and second captures, d_2 between second and third, etc. Total distance moved by the individual, D , is the sum of the d 's. Range, R , an estimate of dispersal, is distance between the two most distant capture points. Time in days between first and second capture is called t_1 , etc. T is total time between first and last capture. Velocities are defined $v_1 = d_1/t_1$ and $V = D/T$. Midpoint age between captures is determined by finding the age midway between two captures after calling the first capture day 0. Correlations between distance or velocity and midpoint age determine whether movements change with age. Midpoint age is used rather than age at start or end of a period between captures because the time between captures differs.

Jolly's stochastic method was used to estimate population size, survival rates, and number of new individuals joining the population (Jolly, 1966). The method of Cook et al. (1967) was used to obtain expected lifespan from average survival rate.

RESULTS

Mate-locating behavior. To locate females, males perch on branches of shrubs and trees 1 to 2 m above the ground. Males start perching at about 0715 and actively perch until 1100. Males gradually stop perching between 1100 and 1200, and rarely perch after 1200. In the afternoon, males mainly visit flowers, or are quiescent on shrubs. Perching males sit on a branch or leaf and dart out at passing objects. Most such objects are other males, whereupon the two males fly about each other for a few seconds, then each returns to or near the same perch as before. One male was observed to perch on a one-meter length of oak branch for two hours during which time he made almost 100 short flights at passing objects. Other males sometimes flew short distances between investigative flights. Males chase a narrow size range of passing objects, so that almost all of the chases are toward other *L. arota*.

Males perch in small clearings in many different topographic situations. A clearing likely to have perching males is about 3–5 m. in diameter, reasonably level, and surrounded by tall trees or steep hills or both. Males were observed to perch in clearings that were in a small valley bottom, on a hillside along an irrigation ditch, and on a ridgetop. More males perch in valleys than hillsides or hilltops because more suitable clearings are found there and the larval hostplant is usually more abundant there.

Mating. If a female flies past a perched male, the male darts after her and flies about 14 cm below her for several meters, then the female lands on a branch and the male lands behind. The male then usually flicks his wings by holding them about 60° from the vertical (about 120° from each other) and vibrating them at small amplitude (only 1–2 mm amplitude for each wing). Sometimes the male vibrates the wings only once or twice per second, and other times he vibrates his wings rapidly (about 10 times per second), occasionally with the vibrations clustered into groups. These two types of wing flicking occurred about equally often, but only one type was seen in any one courtship, except for one courtship in which the male vibrated his wings once per second, then drew closer to the female and vibrated his wings about 10 times per second. Other males did not flick their wings at all, but merely walked to the female and attempted copulation. Whether or not the male flicks his wings, if the female remains quiescent the male crawls alongside and bends his abdomen either right or left to attempt copulation. In the two completed copulations observed, the female was quiescent during courtship and mating. Unreceptive females flap the wings almost full stroke about 10 or more times per second for about 2–5 seconds, while

TABLE 1. Dispersal data for *Lycaena arota*. N = sample size. Dispersal parameters are defined in methods section.

Dispersal Parameter	Males	N	Females	N
Number Marked	107		94	
Number Recaptured	53		37	
Average T (days)	2.56	53	1.91	37
Average t_1 (days)	.94	144	.84	85
Average R (meters)	15	53	29	37
Average D (meters)	16	53	29	37
Average d_1 (meters)	6	144	13	85
Average V (meters per day)	11	53	18	37
Average v_1 (meters per day)	5	144	9	85

sitting. In most courtships the female was previously mated, and she performed this "rejection dance" when the male crawled up to her; the male flew away then or after subsequent rejection dances. Male wing flicking may cause the female to become quiescent and receptive, because if the female is already quiescent, the male usually does not flick his wings.

Courtship and mating occur at the same time as male perching. Copulating pairs were found at 0805, 0920, 1121 and 1200, all in valley bottoms by Scott, and at 0930 and 1326 (Oakley Shields, pers. comm.). 1326 is after the normal perching period, and that observation may represent the mating of a late perching male, or perhaps the mating was initiated during the normal perching period and the pair remained joined until observed (copulation of butterflies lasts rarely up to 30 hours). Nineteen courtships were observed from 0815 to 1036, and one was observed at 1121.

Females rarely mate more than once. Of 60 females dissected (caught several weeks after the species had first appeared), 15 were virgin, 44 had mated once, and only 1 had mated twice. Many virgin females were found in the afternoon, indicating that many females wait until the day after emergence to mate.

Movements. The mark-recapture study was carried out from 30 July to 8 August 1969. Rouch Gulch is a small, dry (except after rains) gulch opening into the Arkansas River, within the pinyon-juniper belt. The larval host, *Ribes leptanthum*, and adult nectar sources were scattered along the bottom, where the recapture study was carried out from the Arkansas River to 300 m. up the gulch. Nearby gulches were sampled to detect dispersal. The proportion of recapture (Table 1) was higher for males, probably because males disperse less than females. Although

TABLE 2. Population parameters estimated from multiple recapture data using the stochastic model of Jolly (1966). Alpha—proportion of marked animals; M—total marked population; N—total population; Phi—probability of survival; B—number of new animals joining the population; SE—standard error.

Day	Alpha	M	N + 1.96 SE	Phi + 1.96 SE	B + 1.96 SE
Males					
July 30	—	—	—	.959 + .394	—
31	.2581	43.13	167.1 + 112.9	.662 + .275	13.1 + 69.4
August 1	.3538	43.77	123.7 + 45.4	.997 + .758	91.6 + 90.2
2	.3836	80.50	209.9 + 164.6	.164 + .159	68.7 + 46.4
5	.1406	13.50	96.0 + 53.5	.593 + .548	47.7 + 63.0
6	.1111	8.00	72.0 + 70.4	—	—
7-8	.1818	—	—	—	—
Females					
July 31	—	—	—	.374 + .242	—
August 1	.0833	14.23	170.7 + 160.8	1.076 + .767	79.8 + 187.8
2	.2283	59.40	260.2 + 200.6	—	—
5,6,7	.1000	—	—	—	—
Both Sexes Combined					
July 30	—	—	—	1.157 + .476	—
31	.1304	57.87	443.7 + 311.1	.489 + .177	24.3 + 146.6
August 1	.2389	57.62	241.2 + 82.8	1.022 + .528	228.4 + 160.7
2	.2970	138.56	466.6 + 253.5	.264 + .224	209.0 + 178.3
5	.1311	40.00	305.0 + 228.4	.438 + .514	105.4 + 155.4
6	.0909	17.50	192.5 + 205.6	—	—
7-8	.1087	—	—	—	—

TABLE 3. Flowers and other fluid sources visited by *L. arota* at the three study sites.

Species	Color	Little Fountain Creek	Rouch Gulch		Smith Creek Cmpgd.
			Male	Female	
<i>Solidago occidentalis</i>	yellow	few	236	158	
<i>Pericome caudata</i>	yellow		52	75	
<i>Eriogonum jamesi</i>	whitish-yellow	few	30	64	
<i>Heterotheca villosa</i>	yellow		5	9	
<i>Chrysothamnus nauseosus</i>	yellow		6	5	
<i>Helianthus pumilus</i>	yellow		2	2	
<i>Allium</i> sp.	white			1	
<i>Rubus parviflorus</i> ¹	—		5	3	
mud	—		1		
<i>Rudbeckia laciniata</i>	yellow	many			
<i>Melilotus alba</i>	white	many			
<i>Aster novae-angliae</i>	bluish white	many			
<i>Apocynum</i> sp.	white	many			
<i>Clematis</i> sp.	cream white	few			common
<i>Achillea</i> sp.	white	few			

¹ Juices of the blue-black berries.

the times between captures for females were less than those for males, the distances moved were much greater for females, resulting in female velocities almost twice those of males. Most individuals of both sexes did not move at all between recaptures, so that the averages of movement statistics in Table 1 are low. Some individuals move considerable distances, however. Maximum distances moved (ranges) for males were 83, 84, 92, 93, 168, and 214 meters, and for females 82, 83, 85, 92, 94, 169, and 186 meters.

Population parameters. The population size in the study area at Rouch Gulch, which is about 300 m. by 100 m., was about 400, declining to 200 at the study's end (Table 2). Females were slightly more common than males since males emerge several days before females and the mark-recapture study was conducted after the peak emergence of males. The number of new animals joining the population was fairly high, about 60 per day for males and 80 for females. The number of animals joining the population and the survival rates are due mostly to emergence and deaths respectively, because few individuals dispersed out or into the area. The 0.164 survival rate for males is low because it represents the survival over a three day period. The average survival rate for males and corresponding expected lifespan was 0.763 (3.7 days) using

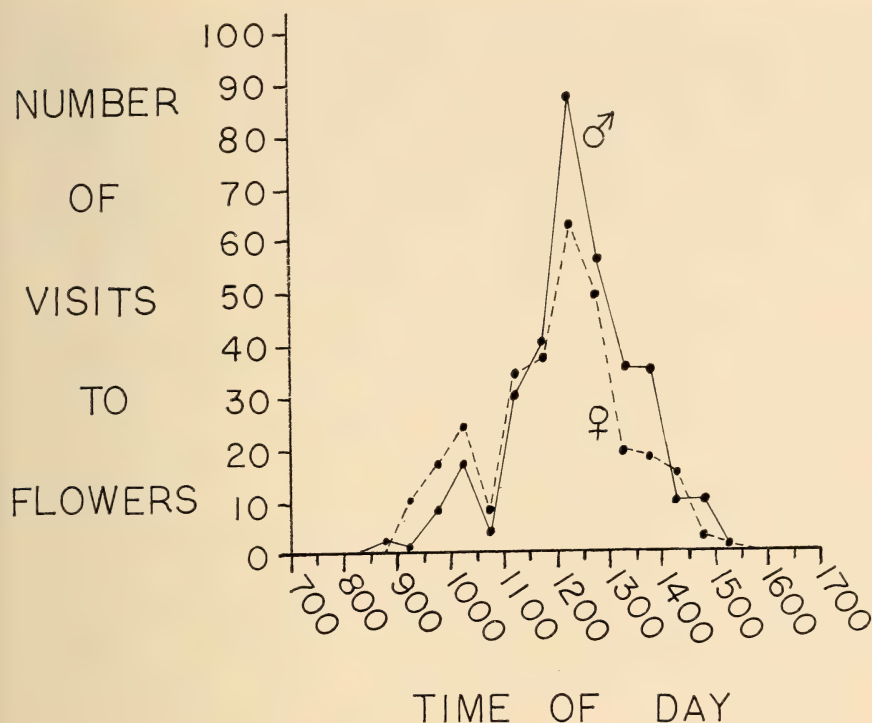


Fig. 1. Number of visits to flowers at various times of day for both sexes of *L. arota*.

method 1, and 0.752 (3.5 days) using method 2 (methods of Scott, 1973). The rate for females was 0.790 (4.2 days) using method 1 and 0.725 (3.1 days) using method 2. The potential lifespan is much longer: males have lived at least 8, and females at least 6, days. The survival rates for both sexes were undoubtedly decreased by extensive predation by robberflies and ambush bugs (see below) and by the weather, which was very hot especially toward the end of the study when the survival rate declined slightly.

Feeding. Both sexes very often feed at flowers (Fig. 1). Flower visits were recorded for 336 males and 296 females. Before 1100, when males are perching, males visit flowers less than females, but after 1100 males visit flowers more than females: 32 males and 58 females were recorded before 1100; 304 males and 238 females after 1100. Both sexes prefer yellow and white flowers but feed on different species at different localities (Table 3). Males preferred *Solidago occidentalis* at Rouch Gulch slightly more than females, and females preferred *Pericome caudata*

and *Eriogonum jamesi* more than males, but this difference seemed mainly because *Solidago* was concentrated at the mouth of the gulch (where males were more abundant) whereas the other plants were more widely distributed. The preference for yellow flowers provided ambush bugs with many meals (see predation below).

Oviposition. Females oviposit on twigs, bark, or dead leaves, on or under bushes of *Ribes* species, especially the subgenus *Grossularia*. Many ovipositions on *R. leptanthum* were observed at Rouch Gulch and Little Fountain Creek. Two ovipositions on *R. montigenum* were observed at Williams Canyon, El Paso County, Colorado. John Emmel (pers. comm.) found ova on *R. leptanthum* near Glenwood Springs, Garfield Co., Colorado. Emmel et al. (1970) found larvae on *R. velutinum* in Nevada which were raised to adults. Gunder (1930) found larvae on *Ribes gracillimum* in southern California. Females often spend an hour or more on the same or a nearby *Ribes* bush alternating oviposition about every five minutes with basking, "hindwing rubbing," and sitting. Females oviposit in the center of a bush just as often as on the outer branches. Nine eggs were laid on rough bark of the thicker branches, 12 were laid on sides of smooth twigs of the thinner branches, and 2 were laid on dead leaves of two different dicotyledons underneath *Ribes* bushes. Females oviposit during the warmer hours of the day from 0900 to at least 1430. The eggs undergo diapause and do not hatch until the next year.

Thermoregulation. Both sexes bask by holding the wings about 60° from vertical, 120° from each other, the same position as in male courtship flicking. Individuals orient their body in any position which brings the wings somewhat perpendicular to the sun, but usually face away from the sun. Both sexes bask more often in morning and late afternoon. A few individuals basked while feeding, but basking is more frequent between oviposition and "hindwing rubbing."

Roosting. One male was found on the leaf of an oak tree (*Quercus gambellii*) at 1708, at Smith Creek Campground, Custer County, Colorado.

Predation. Considerable predation was observed. Robberflies (Asilidae) captured 4 males and 2 females, and missed others. Ambush bugs (Phymatidae) caught one male on *Solidago* flowers and 1 male and 3 females on *Pericome* flowers. A crab spider (Thomisidae) on a composite species caught a female at Little Fountain Creek.

L. arota (and all other Lycaenidae except Riodininae) move the hindwings forward and back, the left and right wing moving in opposite directions, a behavior which I call "hindwing rubbing." Many males

and females did this at all times of day. Basking and hindwing rubbing often follow each other, but do not occur often at flowers. *L. arota* has 2 mm tails on the hindwing, but does not have a conspicuous eyespot next to the tail, so hindwing rubbing may or may not serve to divert bird attack away from the body by drawing attention to the antenna-like tail, as hypothesized for other Lycaenidae (see Wickler, 1968). One male and two females had both hindwings truncated in the manner which may indicate bird or lizard attack.

DISCUSSION

L. arota differs from *L. xanthoides* Boisduval and many other *Lycaena* in that mating occurs only in early morning. The preference of *L. arota* for perching in small clearings contrasts with the open perching sites chosen by *L. xanthoides*; these perching sites correspond to the usual habitats of the two species, mountain foothills for *L. arota* and flat open areas for *L. xanthoides*. Population movements of *L. arota* are small, but several factors combine to counteract the weak dispersal: (1) females disperse much more than males because their velocities are greater and they live longer; (2) the dispersal of some individuals is much greater than that of most others; (3) larval hostplants are rather scattered, resulting in more continuous populations than if the plants were aggregated and these aggregations widely separated. *L. arota* is found almost everywhere in southern Colorado at least between 1500 and 2200 m. in the Wet Mountains and Arkansas River Canyon; and (4) the species is usually very abundant, so that more individuals will move over long distances than if the species was less abundant. Small peripheral populations could therefore be swamped by a few immigrants from a larger population. The species has four named subspecies, but the amount of geographic variation is small considering the size of the range and the many geographic barriers therein. Courtship is very similar among several species of *Lycaena*. Wing flapping of females seems to be a rejection dance in *L. xanthoides*, *L. gorgon* Boisduval, and *L. helloides* Boisduval. *L. xanthoides* males flap the wings with wide amplitude and hover behind or over the female, rarely flapping while sitting behind her. The courtship of *L. gorgon* appears identical to that of *L. xanthoides*, and the courtship of *L. helloides* is very similar to that of *L. xanthoides* except that male *helloides* vibrate the wings with slightly less amplitude while holding them about 30° above horizontal. Other aspects of behavior which are similar in *L. arota* and *L. xanthoides* include basking, feeding behavior (*L. arota* may be more restricted to yellow flowers), and "hindwing rubbing."

SUMMARY

Males perch from 0715 to 1100 on shrubs or trees in small clearings and dart out at passing objects in search of females. Mating usually involves male wing flicking. Unreceptive females flutter their wings until the male departs. Adults are very sedentary, although some individuals move several hundred meters. Both sexes live an average of only 4 days, probably because of hot weather and extensive predation. Both sexes often feed, usually on yellow or white flowers. Females oviposit mainly on *Ribes* branches.

ACKNOWLEDGMENT

I thank Jerry A. Powell for improving the manuscript.

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REPORT OF THE CAPTURE OF AN ADDITIONAL HYBRID BETWEEN
LIMENITIS ARTHEMIS ASTYANAX AND *L. ARCHIPPUS*
 (NYMPHALIDAE)

On 15 October 1972, a wild male interspecific hybrid between *Limenitis arthemis astyanax* (Fabricius) and *L. archippus* (Cramer) [form *rubidus* Strecker] was captured in Durham County nine miles south of Durham, North Carolina. This specimen was captured approximately one-half mile from the site at which a similar hybrid was found two years previously on 10 October 1970 (Platt & Greenfield 1971, *J. Lepid. Soc.* 25: 278-284). The specimen presently is in the collection of A. P. Platt at the University of Maryland Baltimore County.

The recent hybrid (Fig. 1) is in good condition, showing little evidence of being flight-worn. It was quite vigorous in flight and eluded capture several times before being netted. This specimen closely resembles the lab-reared dark morph depicted by Platt & Greenfield (1971); it entirely lacks all remnants of the medial partial white banding (an *archippus* character). On the other hand, the previously caught wild hybrid from Durham was battered, and clearly showed traces of the white



Fig. 1. Wild-caught male *L. arthemis astyanax* \times *L. archippus* (hybrid form *rubidus* Stkr.) collected south of Durham, North Carolina on 15 October 1972 by J. C. Greenfield, Jr. Above: dorsal surface; below: ventral surface.

banding on the ventrum of the forewings. Otherwise, the two specimens appear to be morphologically identical, both representing the dark morph of *rubidus*.

The purpose of this note, in addition to reporting the new hybrid specimen, is to consider why two species as morphologically dissimilar in color pattern as the red-spotted purple and the viceroy should engage in interspecific hybridization in nature, even to the limited extent indicated by the capture of these rare *rubidus* hybrids. The occurrence of two (which are presumably genetically unrelated) in the same locality two years apart is unlikely in view of the scarcity of this form in the wild. A simple explanation is not readily forthcoming.

Adults of the two parental species are, however, quite prevalent in this area; both *astyanax* and *archippus* have been encountered in the same vicinity on multiple occasions, especially in the late summer, often congregating in an old orchard where the ground is covered with rotting fruit. Thus, the usual ecological separation of the two parental species by habitat preference does not seem to be as strongly in evidence in this area as in others.

The fact that both hybrids were collected at almost the identical time of year suggests that there exists a greater tendency for natural hybridization in the late summer and early fall. This contention may be substantiated by examining the collection dates for the known wild *Limenitis* hybrids listed by Platt & Greenfield (1971). Of ten specimens for which dates are reported, nine (including all specimens of form *rubidus*) were collected in the months of August and September.

The single exception to this generality represents the most northern record listed: a hybrid specimen presumed to represent a cross between the western subspecies, *L. arthemis rubrofasciata* Barnes & McDunnough, and *L. archippus*, collected at Beulah, Manitoba on 29 June 1904 by A. J. Dennis (Gunder 1934, *Canad. Entomol.* 66: 39-48). Although originally described under the hybrid name *rubrofasciarchippus* (Gunder), it clearly represents a local variant of hybrid form *arthechippus* (Scudder), and has been so listed by Platt & Greenfield (1971). Both the northern locality and the early collection date suggest that it also resulted from a fall mating, since the larva would undoubtedly have had to overwinter in order to produce an adult by late June. Finally, the most recent record of a rather aberrant morph of *arthechippus* (Johnson & Malick 1972, *Rep. Flora & Fauna Wisc.* 7: 1-6) also has an August collection date.

Both *L. a. astyanax* and *L. archippus* are at least partially triple brooded throughout the eastern U.S. Young (1st-3rd instar) larvae of both species may frequently be found in the wild in Connecticut and Maryland in mid-September (*L. a. astyanax* commonly feeding on *Prunus serotina* Ehrh., and *L. archippus* on *Salix* spp. and *Populus* spp.). Twenty young *archippus* larvae were once collected at Middlefield (Middlesex Co.), Connecticut between 14-21 October 1968, all actively feeding prior to entering winter diapause (Platt, pers. obs.).

Developing larvae of both species are known to construct hibernacula (from the basal portions of tubular rolled leaves spun with silk) and to enter facultative diapause at third instar during the late summer and fall, in response to shortened daylength (Clark & Platt 1969, *J. Insect Physiol.* 15: 1951-1957).

During the summer of 1966, three successive generations of *L. arthemis-astyanax* larvae were reared from a stock obtained from the intergrading population located at Shutesbury (Franklin Co.), Massachusetts (Platt & Brower 1968, *Evolution* 22: 699-718). A total of 8 broods representing the three generations were bred and lab-reared under the ambient daylength for southern New England (Connecticut and Rhode Island) at room temperature. The incidence of diapause among the three successive generations of larvae increased dramatically from July through October (Table 1).

Hong & Platt (in prep.) have determined that the critical photoperiod (that which induces 50% diapause among developing larvae) in Maryland and Vermont strains of *L. archippus*, lab-reared at room temperature, falls between 13.0 and

TABLE 1. Incidence of facultative diapause among three successive generations of *L. a. arthemis-astyanax* butterflies from central Massachusetts—1966 data.

Generation	No. of Broods	No. of Larvae	Larvae Diapausing (%)
1, early summer (July)	1	144	2.1
2, late summer (August–early September)	4	170	22.4
3, Fall (October)	3	66	98.5

Note: All broods were lab-reared on *Prunus serotina* Ehrh. at room temperature under the ambient photoperiod for Connecticut and Rhode Island.

13.5 hrs of light per 24 hr day. Photoperiods of 12 and 12.5 hrs per day induced diapause in 66–89% of the developing larvae representing these two strains.

The ambient daylength at Durham, N. Carolina (approximate latitude = 36°N) decreases from 14:30 in mid-June to 13:25 in mid-August and down to 12:23 by mid-September (Duncombe 1966, The American Ephemeris and Nautical Almanac, U.S. Gov't. Print. Off., Washington, D.C. 512 p.). On the basis of these data, and the diapause information given above, it is reasonable to assume that a high proportion of the larvae of both *L. a. astyanax* and *L. archippus* developing in the wild near Durham during August and September will enter diapause at third instar. Consequently, those larvae undergoing direct development in the late summer and fall will be relatively few.

The matings which produced both of the North Carolina wild hybrids had to occur either in late August or (more likely) in September, a time of year when the adults of both species are at relatively low true population densities, despite their apparent local adult abundance noted above. The late capture dates of both hybrids makes the possibility of their successful backcrossing to parent-type females extremely remote (Platt & Greenfield, 1971). However, seasonably low late summer or fall temperatures perhaps serve to make *L. a. astyanax* and *L. archippus* females more sluggish behaviorally, and hence less particular with regard to selecting their mates. In conclusion, a scarcity of adult butterflies of both species (i.e. mates of the same species) may well contribute to a situation favoring natural interspecific hybridization in *Limenitis*.

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MOVEMENTS OF *NYMPHALIS CALIFORNICA* (NYMPHALIDAE) IN 1972

Recent descriptions of the widespread 1971 eruptions of the California tortoise shell, *Nymphalis californica* Boisduval, (Nymphalidae) (Powell 1972, Pan-Pac. Entomol. 48: 144; J. Lepid. Soc. 26: 226–228) have prompted this report of observations in central California the following year. Weekly observations were made from 4000 to 7200 feet along Interstate Highway 80 in the central Sierra Nevada in Nevada and Placer counties from 17 May–27 October and on 29 March; during intensive collecting in the Sacramento Valley (Yolo, Solano, Sacramento counties) at 10–100 feet from 10 February–31 December; and frequently in the Vaca Mts., Yolo Co., from 14 March–6 July and occasionally through 29 December.

Scattered worn, hibernated *N. californica* were seen in the valley during the weeks of 6 and 13 March and in the Vacas on 14 March. No more were seen until the week of 8 May when large numbers of seemingly fresh butterflies appeared throughout the Vacas. While this flight was in progress, occasional, fresh single tortoise shells could be seen in the valley, mainly along its west edge near Vacaville and Winters. On 26 May at 1700 hours a migration from west to east across the valley was observed from an elevated location just east of Davis, Yolo Co. Butterflies crossed a freeway overpass at the rate of one every 3 minutes, all headed due east. Most were flying from 30–60 feet above the valley floor, but a few were much lower. They continued moving through Davis from west to east most of the afternoon, at least until sunset. The movement was in progress again at 0900 the next day at comparable density. By evening it had dwindled somewhat, but stragglers continued to pass through Davis, moving from west to east, for about five days and a few individuals were seen at the east end of Yolo County, near the Sacramento River, as late as 27 June. On 2 June only one tortoise shell was seen in the Vacas where there had been hundreds before the migration, and on 12 June none were seen at all. Thereafter no tortoise shells were observed in the Vacas in 1972 (although hibernators were again numerous in February and March of 1973). After 27 June none were seen in the valley until mid-September.

On 29 March numbers of hibernated tortoise shells were flying in the Sierran foothills and up to 3000 feet. On 17 May at Baxter, el. ca. 4000 ft., hundreds of fresh tortoise shells lined the roads and clustered about buildings. A few apparently hibernated ones were seen at the Marin-Sierra Camp, near 5000 ft., and at Castle Peak, 7200 ft. On 24 May an enormous migration was observed beginning at 0930 hours, 4.5 mi. E Baxter (ca. 5400 ft.) and continuing for two miles of highway. The butterflies crossed the highway from S to N and moved generally upslope, passing at a rate of one every 5–10 seconds mostly from 3–10 feet above the ground. The migration did not reach to Castle Peak. Only a few live individuals were seen when we returned to the area at 1600 hours. Tortoise shells were abundant up to 7200 feet on 31 May and 7 June, but at much lower densities than observed on 24 May. At 5000 feet they disappeared entirely from 13 June–3 August. From 3 August through 27 October they were continuously present again, but generally at low density. A movement occurred on 29 September when about 80 were observed moving downslope, E to W along I-80, flying into a strong headwind. These again appeared fresh.

At 7200 ft. tortoise shells were seen every week from 17 May–4 October and again on 23 October. The first fresh specimens were observed on 30 June and thousands flew on 21 and 28 July. These seemed to be in local concentrations, mostly around towns, and no definite directional movement was noted. There were virtually none at this elevation on 3 August, when the species reappeared lower down. On 29 September about 110 were seen at Boreal Ridge, mostly moving downslope and westerly along I-80, and a few were seen at Donner Pass.

In the valley, *N. californica* was observed around Sacramento on 11 and 25 September and 6 October. The first autumn sighting at Davis was on 3 October. Thereafter a few were seen each week through 23 October, and scattered sightings were made during the weeks of 13 and 20 November and 11 and 18 December. The bulk of records shifted from east Yolo Co. across the valley toward Vacaville and Dixon through the month of October.

Tortoise shells began flying in the canyons of the Vacas the last week of January 1973. Scattered worn individuals were noted throughout the valley from Winters to Sacramento beginning the second week of March.

In summary, the seasonal changes in distribution of the California tortoise shell in central California in 1972 were:

—A small flight of worn butterflies in the Vacas and valley and in the Sierra foothills in March.

—A large flight of fresh butterflies in the Vacas in mid-May, followed by a mass movement from W to E across the valley floor in late May depopulating the Vacas for the rest of the season.

—A large flight of fresh butterflies at 4000 feet in the Sierras in mid-May, developing into a huge upslope migration in late May, disappearing in early June.

—A large flight at 7000 feet in late July, disappearing in early August. Fresh butterflies, but no directional movement noted; concentrations local.

—A small to moderate downslope migration at both 5000 and 7000 ft. on 29 September, with scattered records of an autumn flight from late August through late October.

—A small flight in the valley from mid-September into mid-December, mostly in October, with an east-to-west drift, presumably accounting for the spring 1973 butterflies in the Vacas.

Over-all, these records suggest that the California tortoise shell migrated eastward and upslope in spring, and westward and downslope in fall. If we do not postulate estivation or adult diapause, the generation sequence would be about as follows: a brood of new adults, progeny of hibernators, emerged in May in both the Vacas and Sierra foothills. The Vaca insects moved eastward across the valley floor (where *N. californica* does not breed, there being no *Ceanothus*) *en masse* in mid-May, while their Sierran counterparts moved upslope *en masse* at the same time. The two currents probably fused. The progeny of these insects emerged in July–August, with no well-defined migration, but perhaps a downward drift. The surge of butterflies moving downslope at the end of September may have represented a third, markedly smaller, generation. These would be the butterflies which appeared at low elevations at low densities and drifted across the valley floor in October. On this schedule each “brood” would take about eight weeks. (Generations of Milbert’s tortoise shell, *N. milberti* Latreille, take about seven weeks in New York.)

During the 24 May eruption I examined 189 freshly killed specimens (103 females). The females were all pre-reproductive, with no mature ova but substantial fat bodies. Of 35 examined for spermatophores, 32 were virgins. Only 11 females of the late July surge were collected, but all were also pre-reproductive. So, too, were 16 collected in the 29 September surge. On the other hand, most of the females collected between the big flights, when the species was at low density, were gravid and/or contained spermatophores, at least until early September.

The brood sequence of *N. californica* is extremely obscure. In the complete absence of reports or observations of larval outbreaks in 1972 the number of generations can only be inferred from the condition of the adults. Although the data strongly suggest three broods, they do not rule out the possibility of only one—emerging in May, summering in the high Sierras, with only sporadic reproduction, and returning downslope to hibernate. Nymphaline adults are capable of extended periods of inactivity, but the reason for large-scale activity at eight-week intervals can only be described as arcane. Alternatively, one can postulate two “populations” in the Sierra, one resident and breeding without migration, one migratory and perhaps not breeding at all.

Clearly, while the generalized picture Powell presents of a species erupting at irregular intervals from persistent epicenters (e.g. Mount Shasta) is broadly accurate, there were unexpected elements of regularity in the 1972 movements whatever the brood sequence that produced them. Following the 1971 outbreak *N. californica* appears to have colonized an extensive area and to have set up a migratory pattern which is seasonally adaptive. To judge by past history, its occupation of these areas will be temporary. The 1972 data raise some interesting questions: is it typical of mass movements that the females are not in reproductive condition? And how quickly do they come into condition? If females do not mate until after the migration, the chances of outbreeding are substantially increased—a possible genetic rationalization of eruptive periodicity (Brown 1957, Quart. Rev. Biol. 32: 247–279).

Collections were made with the help of Dr. E. W. Jameson, Jr. and Mr. Allen Allison, both of the Department of Zoology, University of California, Davis, and Mrs. Adrienne R. Shapiro.

ARTHUR M. SHAPIRO, *Department of Zoology, University of California, Davis, California 95616.*

PHILOTES RITA (LYCAENIDAE) IN A SANDSTORM

Between 0730 and 0810 MST, on an overcast day, 4 September 1970 (at 10 road mi. NE of Goblin Valley turnoff from Hwy. 24, on Hwy. 24, Green River Desert, Emery Co., Utah), Scott Ellis and I encountered *Philotes rita* Barnes & McDunnough spp. during a strong windstorm. We collected 19 *rita* clinging to stiff *Ephedra* plants in ca. 30–40 mph winds. The winds at first were calmer with no blowing sand but soon a gusty sandstorm from the SW hit with fine sand particles. Other plants in the area, including *Eriogonum leptocladon* Torr. & Gray var. *leptocladon*, *rita*'s foodplant here, were not nearly as upright in the wind as the *Ephedra*. Most of the *rita* perched in a head-down position (3–4 head-up) on the uppermost parts of the *Ephedra*, with the primaries tucked inside the secondaries, directed away from the wind's angle, and buffeted by the wind. They clung on by their legs wrapped part-way around a stem. When approached or disturbed, some flopped down into the plant or onto the ground with the wind (they were still alert). These *rita* have been genitally determined and represent an unnamed subspecies to be described elsewhere.

OAKLEY SHIELDS, *Department of Entomology, University of California, Davis, California 95616.*

NOTES AND NEWS

Recent Letters

Dear Dr. Sargent:

In the last issue of the "Journal of the Lepidopterists' Society" (Vol. 27, No. 3, 10 August 1973, p. 210–219), there is an interesting study about the Biology of *Prepona omphale octavia* Fruhstorfer, by Alberto Muyshondt, of San Salvador, C.A., presented "as this is the first time the life cycle of *P. omphale octavia* is fully described," However, it is necessary to note that I published a long time ago (1933), about the same species and surely the same subspecies, because the names of E. Le Moul't (1932–33), in my opinion are subject to critical study and revision, in Guatemala occidental (Department of Quezaltenango).

I am sorry I cannot send you a reprint of my work because I have only one in my library. The entire reference of this study is: *Novitates Entomologicae*. Paris. Fasc. 3–4, 30 déc. 1933, p. 24–26, 1 pl. couleurs. "Observations biologiques sur les différents états de *Prepona omphale guatemalensis* Le Moul't (Lép. Nymphalidae) par René Lichy." Also in: *Nov. Entom.*, janvier 1932, 2e. année No. 1, 1er. supplément, p. 11, pl. couleurs. About the species, subspecies and aberrations described by E. Le Moul't, cf. collection of "Nov. Entom."

I send this notice to you for the next "Journal." Thank you very much. Very best wishes.

Yours sincerely,
RENÉ LICHY
"Yavita"
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Dear Sirs,

In a recent issue of your Journal (Vol. 27, no. 1, pp. 8–12, 1973) Professor Sargent concludes his short article with the following statement, “. . . numerous other experimental results (Sargent, 1968, 1969a and b) fail to support the reflectance matching mechanism proposed by Kettlewell (1955) and Ford (1964) to explain the selection of appropriate backgrounds by bark-like moths. On the contrary all of the evidence to date supports the view that these background selections are genetically fixed or innate responses.”

I would like to ask one simple question: if in fact this statement is true, I would like Professor Sargent's views as to how the two morphs of *Biston betularia* (f. *typica* and its melanic f. *carbonaria*) succeed so well in correct choice of backgrounds—two very different ones.

Yours sincerely,
DR. H. B. D. KETTLEWELL
Department of Zoology—Genetics Unit
South Parks Road
Oxford, England

ED. NOTE: Since my views are solicited, I would suggest that the two morphs of *Biston betularia* differ both at the loci controlling the visible expression of melanism and at loci controlling background resting preference. I would assume that the different background preferences of the two morphs are fixed or innate, in the sense of being unmodifiable during the life of the insect. In such a situation, one would expect the evolution of mechanisms, such as the formation of supergene complexes, to insure that each morph inherits the appropriate background preference.

OBITUARY

KENNETH JOHN HAYWARD (1891–1972)

Kenneth John Hayward was born on March 7th, 1891 in the small village of Pitney, near Taunton, in Somerset. At the age of eighteen he was already earning a living in London as an electrician, and by 1912 he was working on the Aswan dam in Egypt in the same capacity. He joined the forces soon after the outbreak of war in 1914, serving in France, Greece and Cyprus, and returning to Aswan with the rank of Captain in 1919. In 1922 he returned to London and eventually secured a post as an engineer with the land-owning Argentine La Forestal company, which he took up in 1923 and held till 1929. It was during these years that he spent at Villa Ana and elsewhere in the Chaco that he amassed the very large collections that he presented almost in their entirety to the British Museum (Natural History), to be added to those he made whilst in Egypt.

About 1930 he became associated with Albert and Adolph Breyer, both keen entomologists, working with them at Patquia, La Rioja, Argentina. His status as an entomologist, however, was only realized beyond doubt when in 1934 he was appointed in that capacity to the Agricultural



Experiment Station of Concordia in Entre Rios, Argentina. From there in 1940 he transferred to the Agricultural Experiment Station at Tucumán, where his wanderings ceased. Here in 1944 he joined the Instituto-Fundación Miguel Lillo of the National University of Tucumán, which conferred an honorary doctorate on him in 1950. Of recent years he enjoyed the title of Professor Emeritus. He died in Tucumán on May 21st, 1972.

Hayward was a rather tall, spare man, somewhat reserved and seeming to be under tension from the sheer volume of work he always had in hand. At one time I used to receive from him with the greatest regularity, and much too frequently for my peace of mind, parcels of specimens and long numbered lists upon which I was required to fill in their names. I was unable to keep pace. Undeterred, he turned to others to supplement his identification service. It was only when, by these means, he had secured a firm basis that he began to make worthwhile contributions to our knowledge of the entomological fauna of the Argentine Republic.

I don't know enough about his publications to be able to evaluate them, but when I was Editor of the *Entomologist* (and ever since then) he regularly sent me notes on butterfly migrations in Argentina. W. H. Evans thought well of his work on Hesperidae, considering the relatively limited facilities available to him.

I am told that he was married, but "separated many years ago" and that he had a married daughter living in England with a son now at University. An obituary was published by one of his associates, Dr. Willink, in *Physis* 81: 83 and another appeared in "La Gacete" S.M. de Tucumán, May 22nd.

NORMAN D. RILEY, *British Museum (Natural History), London, England.*

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——— 1961a. Some contributions to population genetics resulting from the study of the Lepidoptera. Adv. Genet. 10: 165-216.

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Address all correspondence relating to the *Journal* to the editor. Material not intended for permanent record, such as current events and notices, should be sent to the editor of the *News*: Ron Leuschner, 1900 John Street, Manhattan Beach, California 90266.

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JOURNAL

of the

LEPIDOPTERISTS' SOCIETY

Published quarterly by THE LEPIDOPTERISTS' SOCIETY

Publié par LA SOCIÉTÉ DES LÉPIDOPTÉRISTES

Herausgegeben von DER GESELLSCHAFT DER LEPIDOPTEROLOGEN

Publicado por LA SOCIEDAD DE LOS LEPIDOPTERISTAS



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Memoirs of the Lepidopterists' Society, No. 1 (Feb. 1964) A SYNONYMIC LIST OF THE NEARCTIC RHOPALOCERA

by CYRIL F. DOS PASSOS

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The Lepidopterists' Society is a non-profit, scientific organization. The known office of publication is 1041 New Hampshire St., Lawrence, Kansas 66044. Second class postage paid at Lawrence, Kansas, U.S.A. 66044.

JOURNAL OF THE LEPIDOPTERISTS' SOCIETY

Volume 28

1974

Number 2

NOTES ON THE LIFE CYCLE AND NATURAL HISTORY OF BUTTERFLIES OF EL SALVADOR. III. *ANAEA* (*CONSUL*) *FABIUS* (NYMPHALIDAE)

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This is the third article in a series dealing with what my sons and I have found related to the life cycle and natural history of Rhopalocera encountered in the vicinity of San Salvador, capital city of El Salvador. As stated in our previous articles, the purpose of the series is to present the life cycle, including observations on the behavior of the early stages and adults, and to make known the foodplant of the local species of Neotropical Rhopalocera, as according to the literature many of them are incompletely known, and have been classified solely on the adult morphological characteristics. A major difficulty has been the identification of the species described. To overcome it, we have requested the help of Museums, mostly the Allyn Museum of Entomology, where Dr. L. D. Miller has made the identifications.

This particular species has been placed through time in various genera by different authors: Cramer (1775) in *Papilio*, Hübner (1807) in *Consul*, and *Protogonius* (1819), Duncan (1837) in *Fabius*, and Doubleday (1844) in *Helicodes*. A host of specific names has been used too, among them the best known is *hippona* used by Fabricius (1777). We follow the name used by Comstock (1961), *Anaea (Consul) fabius* Cramer. Comstock leaves open the possibility that some subspecies might be valid.

In our first article (Muyshondt 1973a) a summary description of the country and its climatic conditions was made. *A. (C.) fabius* is a dweller of wooded land, preferring ravines or creeks that cross coffee plantations (that are man made forests in this country). We have found the species from sea level to about 1500 m. In October 1969 we saw for the first time a female ovipositing on a plant that was identified as a Piperaceae, near

Izalco, a town located about 45 km. W of San Salvador. In October 1970, larvae in different stadia were found and collected near the village of Zaragoza (some 15 km. SSW of San Salvador), this time on two different species of the same Piperaceae. A few days later, in the same Zaragoza area, another female was observed ovipositing and eggs were collected, put in individual transparent plastic bags and brought back to our laboratory. Photographs were made of the eggs and the subsequent stages of development until the adults emerged. Records of the developmental time, size and mortality were kept, and specimens of the different stadia were kept in alcohol. Since then the species has been reared during various months of the year to establish seasonal variations. Several species of Piperaceae, in addition to the ones on which the eggs and larvae were found, have been successfully used as foodplants. Breeding in all instances has been carried out under ambient lighting and temperature conditions. No moisture control was kept, but it was usually very high due to the fact that the material was kept in plastic bags, even though these were cleaned every day.

Life Cycle Stages

Egg. Translucent white with greenish tinge, almost spherical, with flattened base and depressed micropyle, surface smooth, and about 1 mm in diameter; all hatched in 5 days.

First instar larva. Head light brown with darker markings, roundish, disproportionately large in relation to body, that is wedge-shaped from head to caudal end; grayish brown with scarce fine pilosity. After feeding on the leaf changes color to greenish-brown with tiny yellow markings. Measures upon emerging about 2 mm and grows to about 4.4 mm before moulting in five days.

Second instar larva. Head black with tiny tubercles, white and yellowish, scattered mostly alongside lateral borders of epicrania. Two stubby horns on apex of epicrania. Body dark brown (almost black) with lighter peppering, thickening from first thoracic segment to first abdominal segment, tapering then gradually to 10th abdominal segment. Grows to 0.9–1 cm in six days.

Third instar larva. Head black with prominent tubercles, white or yellow, scattered in the area between ocelli and epicranial horns, which are now thicker, slightly longer and terminated in several short spines bearing thin setae. Body dark brown to black with heavy yellow sprinkling mostly on thoracic and mid-abdominal segments. On the caudal portion of the abdomen, sprinkling concentrated along spiracular area. Larvae grow to 1.5–1.8 cm in 4–5 days.

Fourth instar larva. Head black with parallel vertical yellowish lines starting at adfrontal zone, the last and smallest located behind the ocelli. Head as thick as thickest abdominal segment. Body very dark brown or black with white sprinkling mostly concentrated on thoracic segments. Inconspicuous warts with tiny spines placed one at each side on subdorsal area of third thoracic segment. Scarce but noticeable setae alongside subspiracular area. White sprinkling on fourth abdominal segment and spiracular zone of caudal abdominal segments. Tubercles on head very abundant, most prominent of them yellow. Stubby horns with many tubercles and thick short spines with setae. Grows to 2.4–2.6 cm in 4–5 days.

Fifth instar larva. Head black with some black and many yellow tubercles most prominent at sides of epicranium, and two near the upper adfrontal area. Frons

yellow, then yellow parallel vertical bands low on the epicranium. Horns as in fourth instar, but thicker and slightly longer. Body now dark green with dark red stains dorsally, mostly on thoracic segments and last abdominal segments. Spiracula yellow, surrounded by greenish ring. Spiracula on 2nd abdominal segment placed higher than the rest, same as spiracula on eighth abdominal segment. White pepper-ing scattered on body mostly on thoracic segments. Body now thicker than head, and short in relation to thickness. Grows to 3.5–3.8 cm in 9 or 11 days.

Prepupa. Very thick and incurvated laterally, body all green. Duration two days.

Pupa. Generally light green, occasionally light brown. Cremaster shining black. Abdominal segments taper sharply from wingcases (the thicker part of the pupa) to cremaster; thoracic segments taper gradually to slightly bifid head. Measures 1.6–1.9 cm long, 1.2–1.3 cm laterally at widest point, and 1–1.1 cm dorsoventrally at thickest point. Duration 10–11 days.

Adult. Shape of wings unique in genus. Forewing with projected angle starting at apex, going outwards to vein M 2, then sharply inwards to vein M 3, then slightly convex to tornus. Color dorsally dull black with conspicuous elongated yellow spot apically and row of three yellow elongated spots going from mid-costal area towards mid-outer margin, with an oval one under the last. Orange band covering basal and discal areas, parallel to black inner margin, not reaching tornus. Hindwing rounded with more or less spatulate tail on vein M 3, and sharp anal angle. Color orange except for dull black border alongside outer margin, with row of 4 yellow spots in black area, between tail and anal angle. The underside of both fore and hindwings is grayish-brown of varying shades, with no definite pattern. The body is orange, eyes reddish, antennae black basally, then orange turning to yellow, the tip usually black.

No striking differences exist between the sexes, males somewhat smaller than females and having orange hairs alongside inner margin of hindwings. Much variation in shape of projected angle of forewing and of tails on hindwing, even among individuals emerged during same month. Total developmental time for this species varies from 45 to 50 days, females usually taking more time than males.

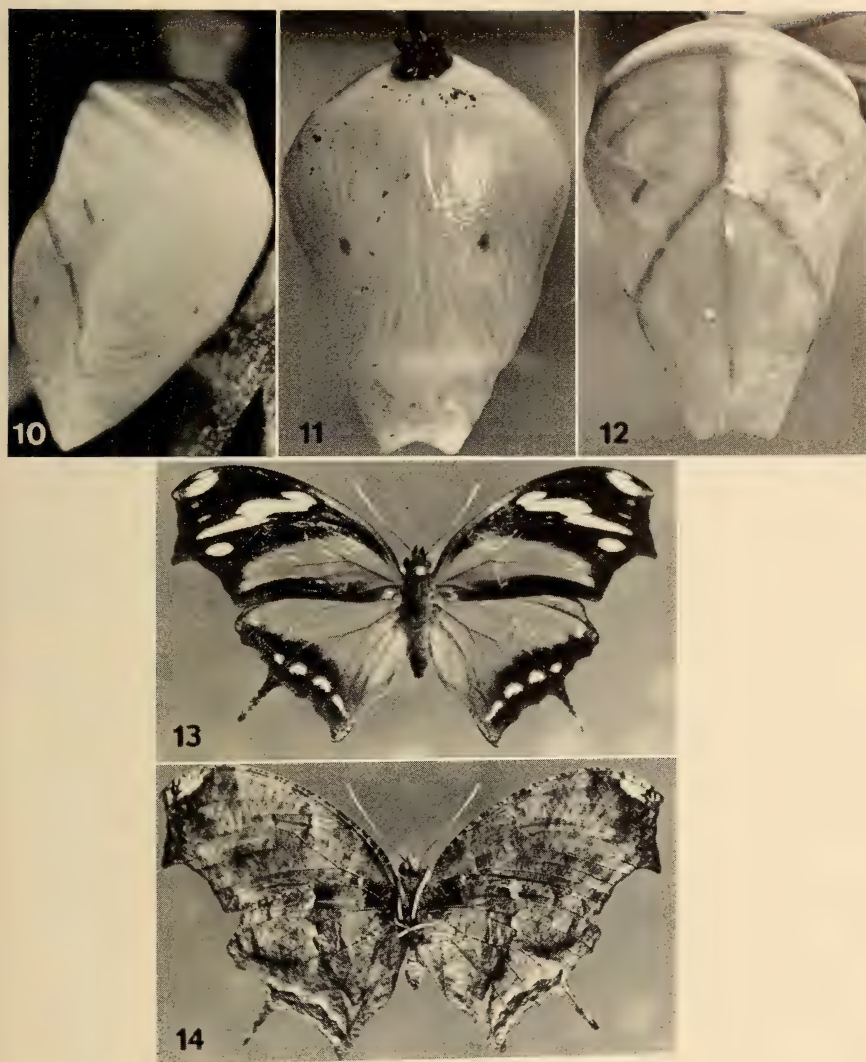
Natural History

All the plants on which we have found eggs and larvae of *Anaea* (*Consul*) *fabius*, and all the plants we have used as substitute food for the larvae, belong to the Piperaceae family. We have collected eggs and larvae on *Piper tuberculatum*, Jacquin, *P. auritum* H.B.K., and *P. umbellatum* L. and have used some others, not determined, with success when unable to obtain the original foodplant. Piperaceae in general are very common all over the country, among heavy second-growth plant communities, in humid ravines, along creek beds and coffee plantation roads. All the foodplants we have used have aromatic properties due to the content of essential oils, and usually have bitter flavor.

The recently emerged larvae of *A. (C.) fabius* eat the egg shell completely and stay under the leaf without further feeding for one day. Then the larvae move to the border of the leaf, usually to the tip, select a terminal of a vein, eat around it and prolong the vein with frass stuck with silk. The larvae use this as a perch when not feeding, and usually keep the head pointing outwards. This characteristic behavior is kept through the first, second and third instars. It sometimes happens that



Figs. 1-9. *Anaea (Consul) fabius* Cramer: (1) egg, about 1 mm; (2) first instar larva recently hatched, about 2 mm; (3) first instar larva 4 days later, about 4 mm; (4) second instar larva, about 1 cm; (5) third instar larva, about 1.7 cm; (6) fourth instar larva, about 2.4 cm; (7) fifth instar larva, two days after moulting, about 3.6 cm; (8) head of fifth instar larva; (9) prepupa, showing peculiar attitude.



Figs. 10-14. *Anaea (Consul) fabius* Cramer: (10) side view of pupa, about 1.7 cm long, 1 cm dorso-ventrally; (11) ventral view of pupa; (12) dorsal view of pupa; (13) adult, dorsal view, about 6.3 cm; (14) adult, ventral view.

the whole leaf is eaten during this period, in which case the larvae move to another leaf where they make a new perch using the same system. During the fourth instar the larvae wander about the plant for two or three days, choose a larger leaf, and roll a portion of it, using silk, in the shape of a long funnel. From then on, until pupation, they remain

inside of this funnel while not feeding, the head blocking the wide end and expelling the excreta through the narrow end. After feeding, usually done at dusk, the larvae come back to their hiding place, put the caudal end in position and crawl backwards into the funnel. When ready to pupate, the larvae abandon their funnel, wander about the shrub until they find a suitable place (a twig or a leaf, not always in the same plant, but always among heavy foliage), weave a small pad of silk, affix thereon the anal prolegs and stay there with the body incurvated laterally, not hanging. Just before doing this, the larvae expel an amount of greenish liquid mixed with excreta. The larvae of *A. (C.) fabius* through all instars are very slow moving, and when touched with a thin object make pushing movements with the tubercled head, and emit a pungent, though not disagreeable, scent, apparently from an eversible gland located anterior to the front thoracic legs.

The pupae are either light green or light brown, regardless of environmental conditions, at least under laboratory conditions. We have simultaneously had green and brown pupae from larvae raised on similar diets, and among green leaves. The pupae are rather stiff and generally do not react when handled. At most, the pupae effect a short lateral swing.

The adults of *A. (C.) fabius* are, with the adults of *A. (C.) electra* Westwood, the slowest of all the Charaxinae found in El Salvador, even if, compared with other butterflies, they are rather fast. Males are very aggressive, and exhibit strong territorial defense behavior. They sit on top of a leaf, or at the side of a tree trunk, wings flapping from time to time, and will dash at anything flying near their resting place, whether it is another butterfly or just a falling leaf, then will return to the same or a nearby perch. Both sexes are very fond of feeding on fermenting fruits, sap of trees and even animal excrements. We have never seen them at flowers.

When the females are ready to oviposit, they fly rapidly to the area where the foodplants are located, fly around one of the plants several times, and then approach the chosen one rather hesitantly, alight under a leaf, usually of medium development, and deposit one egg on the undersurface of it. They usually repeat the action on the same plant or on a neighboring one several times before flying away.

Many times, when breeding this species, we have had tachinid larvae kill the larvae of the butterfly, generally when they reach the fifth instar or shortly after pupation. Some specimens of the adult of the tachinid have been sent to the U.S. Department of Agriculture for determination and these have been identified by Dr. C. W. Sabrosky as *Chrysotachina* sp. Another parasite found, even if very seldom,

is a Chalcididae, determined by Dr. B. D. Burks, of the U.S. National Museum, as *Spilochalcis* sp., probably a new species. This latter parasite is polyembrionic and practically fills the pupa shell. In the case we sent for determination, 55 adults of the parasite emerged from one pupa. Apparently more than one egg had been injected, as males and females of the parasite were found.

The larvae of *A. (C.) fabius* are very prone to a disease that softens their body until they burst and die. We have not witnessed any case of predation.

DISCUSSION

According to Comstock (1961), the life cycle of *Anaea (Consul) fabius* has been at least partially described by several authors: Stoll (1787), Sepp (1852) (both under the name *Papilio fabius*), and Müller (1886) (under the name *Protopogonius drurii*). Amazingly, Sepp mentions *Mespilus americana* (sic) as the foodplant. The genus *Mespilus* has been replaced, according to Standley (1922), by the genus *Crataegus* L. and belongs to the Malaceae (Apple family). In El Salvador at least, this species, *Anaea (C.) fabius*, feeds exclusively on Piperaceae. Was this a case of misidentification, or was a wandering pre-pupal larva or a pupa found in a nearby *Mespilus*?

Apparently this is the first time a complete description of the life cycle of this species has been made, with photographs of the different stages as was the case with the descriptions of the life cycles of the other two Charaxinae, *Prepona omphale octavia* Frühstorfer and *Anaea (Zaretis) itys* Cramer (Muyschondt, 1973a, b).

The egg of *A. (C.) fabius* is exactly like the egg of *A. (C.) electra* Westwood (with whom it shares the foodplant), *Anaea (Memphis) eurypyle confusa* Hall, *A. (M.) pithyusa* R. Felder and *A. (Z.) itys* (this last one is yellowish instead of greenish). The larvae are very much like the larvae of *A. (C.) electra*, even in coloration, and it is very hard to tell them apart until the fifth stadium, when the color of the head is lighter in *A. (C.) electra*. The larvae of *A. (M.) e. confusa* and *A. (M.) pithyusa* have the same shape as *A. (C.) fabius* but a completely different coloration. The larval behavior of the whole group of *Anaea* spp. mentioned, with the exception of *A. (Z.) itys*, is very similar in all instars from one to the other; they make the perch with the bared vein during the first stadium, and the funnel-shaped refuge during the fourth instar. During the pre-pupal stage all *Anaea* spp. we have reared behave alike: they do not hang like most Rhopalecera, but stay incurvated laterally, the body in contact with the supporting object.

The species *A. (C.) fabius* exhibits a very effective defense mechanism based primarily on crypsis during the early stages: the translucent small egg is very hard to spot on the shadowy under-surface of the leaf; then the first, second and third instar larvae spend most of their time perched on the prolonged vein of a leaf, resembling to perfection a dried portion of it. The fourth and fifth stadia are spent hiding within the funnel-like contraption they make with their chosen leaf, and its entrance is blocked by their massive and tubercled head. The color and relative smallness of the pupae make it hard to locate among the profuse foliage of the shrubs. This cryptic behavior is common to most *Anaea* spp. found in this country, with the exception of *A. (Z.) itys*. But even this one, as well as the other Charaxinae we have studied, *Prepona omphale octavia*, behaves in the same manner up to the third instar.

The adult of *A. (C.) fabius*, while in flight, can very easily be mistaken for a faster flying *Licorea* sp., *Tithorea* sp. or even an *Heliconius telchinia* Doubleday, all of which belong to families classically considered unpalatable: Danaidae, Ithomiidae and Heliconiidae. This group is supposed to form a Müllerian mimicry complex. It is our opinion that *A. (C.) fabius*, feeding exclusively on Piperaceae, plants well-known for their content of essential oils and other at least bitter compounds, could very well have developed protective unpalatable characteristics, which augment its imitative coloration, and so effect its Müllerian mimicry in this complex. This would explain the slowness of *A. (C.) fabius* in comparison with the other swift flying *Anaea* spp. But *A. (C.) fabius* adults do not solely rely on this defense mechanism: they also have the cryptic coloration of the underwings which makes the individuals inconspicuous among dry leaves. The species seems to enjoy a dual defense: unpalatability plus crypsis.

It is to be noted that this duality of defense mechanisms seems to exist even during the larval stage. In addition to the cryptic behavior described above, the larvae, when molested, extrude a gland located anterior to the prothoracic legs and emit a pungent scent.

In spite of the complicated defense mechanisms of *A. (C.) fabius*, and the dusk and dawn feeding habits of the larvae, that minimize the risk of day-feeding predators, the mortality imposed on the species by ingestion-parasites is considerable. These ingestion-parasites are the Tachinidae that deposit their eggs on the leaf where the larvae are feeding. Regardless of the short developmental period (less than two months), which would allow no less than six generations a year, this species is rather scarce in the country, and mostly so during the rainy season. This fact leads us to deduce that parasites (Tachinidae in particular), are the principal factor that keeps the species in check.

Parasites, being in general small animals, are, according to Janzen & Schoener (1968), much affected by dryness, such as is the case in El Salvador from November to April. Thus it is during these months that *A. (C.) fabius* should be less affected by them and therefore should be more abundant. That is exactly what happens in fact.

ACKNOWLEDGMENTS

We are deeply grateful to Stephen R. Steinhouser for giving us access to his technical library and for sharing with us his own observations on adults of this species. To Dr. Lee D. Miller of The Allyn Museum of Entomology, who identified the species for us, and Dr. Theodore D. Sargent, who revised the manuscript, we express our gratitude. The eldest of this group is very thankful for the help and cooperation of his five boys, without which this study would not have been possible. We also thank Drs. B. D. Burks and C. W. Sabrosky for identification of the parasites mentioned. Specimens of early stages and adults have been deposited in The Allyn Museum of Entomology, Sarasota, Florida.

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THE REARING OF THE NEOTROPICAL BUTTERFLY *MORPHO PELEIDES* (NYMPHALIDAE) ON PEANUTS

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This paper summarizes a rearing study of *Morpho peleides* Kollar (Fig. 1, as form *limpida* Butler) on the leaves of peanut, *Arachis hypogaea* L. (Leguminosae) under laboratory conditions in Costa Rica and Appleton, Wisconsin. It is generally known that the caterpillars of several South American species of *Morpho* feed on a variety of leguminous vines, shrubs, and trees (d'Aranjo e Silva et al., 1968). A recent study of the life history of *Morpho peleides* in Costa Rica and El Salvador reports several papilionaceous legumes as foodplants of caterpillars (Young & Muyschondt, 1973). But there are no records of this butterfly feeding on peanut, which has a very widespread geographical distribution in the New World tropics (Leon, 1968).

This study was undertaken primarily for the purpose of developing reliable and relatively easy methods for culturing the butterfly, as a prerequisite to experimental studies on the biochemical and behavioral aspects of feeding in *Morpho* caterpillars. The choice of *Morpho peleides* was made since mated females are very easy to obtain in the wild, and also because it is a member of the very frequently encountered *achilles* complex (or super species) in all of tropical America.

METHODS

The object of this study was to rear individuals from the egg through the adult stage. Eggs were obtained by confining a single healthy female butterfly in a 25 × 37 cm clear plastic bag containing a piece of fresh foodplant (usually *Mucuna urens* was used for this purpose). By repeating this procedure with several different females, a large number of viable eggs were obtained. Eggs were harvested from the leaves each day and the foodplant cuttings were replaced as they dried up. Females were removed from the bags and fed once or twice daily on juices from rotting banana. On the average, a mated female about 3–5 days old when caught lives three to four weeks in this manner and lays between 10 and 105 eggs (an average of 65 eggs, N = 28 females) during this period. Eggs were subsequently transferred to smaller plastic bags for hatching, keeping them at densities of usually 15 to 20 eggs. Eggs from each female were raised separately. All females used in this study as sources of eggs were wild caught at two mountain localities (1000 m. elev.) in the central



Fig. 1. *Morpho peleides limpida* Butler from Cuesta Angel, Heredia Province, Costa Rica: female (above), and male (below). About one-half natural size.

TABLE 1. Developmental time (days) and some related ecological statistics for *Morpho peleides* on natural (*Mucuna urens*) and novel (*Arachis hypogaea*) foodplants in the laboratory.*

Statistic	Egg	Instar 1	Instar 2	Instar 3	Instar 4	Instar 5	Pupa	Total
<i>Mucuna urens</i>								
Devel. time (days)**	12.3	13.0	10.5	11.2	20.4	24.2	14.0	105.6
S.E.	± 0.1	± 4.1	± 1.2	± 2.2	± 4.0	± 2.9	± 1.2	
Body length (mm)	2.1	12.5	18.3	28.5	38.3	73.2	38.9	
S.E.	± 0.0	± 2.0	± 2.3	± 2.6	± 4.1	± 4.1	± 2.4	
Head capsule width (mm)		2.0	2.5	4.3	5.5	6.8		
S.E.		± 0.1	± 0.1	± 0.3	± 0.4	± 0.4		
N	275	251	251	243	243	243	240	
No. which died	0	6	0	8	0	0	3	
<i>Arachis hypogaea</i>								
Devel. time (days)	12.3	13.0	10.3	11.0	20.2	23.6	14.4	104.8
S.E.	± 0.1	± 2.2	± 0.8	± 0.7	± 1.2	± 0.9	± 1.0	
Body length (mm)	2.1	12.4	18.4	28.6	38.0	73.0	39.0	
S.E.	± 0.0	± 0.3	± 0.6	± 0.9	± 0.9	± 2.0	± 1.6	
Head capsule width (mm)		2.0	2.5	4.3	5.5	6.8		
S.E.		± 0.1	± 0.1	± 0.2	± 0.2	± 0.3		
N	250	232	232	221	221	220	220	
No. which died	18	0	11	0	0	1	0	

* The data are pooled here for measurements taken in San José, Costa Rica and Appleton, Wisconsin since results were very similar in both places. The raw data from each of these localities are, however, available upon request. The measurements of ecological statistics were always made on both foodplants simultaneously, so that all individuals were always exposed to the same environmental conditions (see text for a description of laboratory conditions).

** See also Young & Muysshondt (1973) for other estimates of egg-adult developmental time and size range in *Morpho peleides*.

highlands of Costa Rica (Cuesta Angel on the Caribbean slopes of the Central Cordillera, and Bajo la Hondura on the Pacific slopes). The butterfly is unusually abundant at both places, and females were easily baited with rotten fruit.

A pilot rearing study was performed at Lawrence with a few eggs of *M. peleides hyacinthus* and *M. polyphemus* sent from El Salvador by Alberto Muysshondt. These eggs were reared on peanut under green house conditions. The caterpillars, in second instar, were then transported to Costa Rica and rearing continued on peanuts obtained locally. The success of this pilot study prompted the initiation of a larger scale rearing of *peleides* caterpillars simultaneously on *Mucuna urens*, a natural foodplant (control), and peanuts, a presumably novel foodplant for this species. This study was conducted in two parts: the first experiment was run in San José, Costa Rica, and the second one later in Appleton, Wisconsin (Lawrence University).

A total of 300 eggs was used for the Costa Rican study. These were



Fig. 2. Thriving laboratory cultures of *Morpho peleides* and *M. polyphemus* on peanuts at Lawrence University: (A) *M. peleides*—fourth instar; (B) *M. peleides*—fifth instar; (C) *M. polyphemus*—fourth instar; and (D) an adult peanut (*Arachis hypogaea*) plant (about $\frac{1}{2}$ m tall) bearing two fourth instar *Morpho* caterpillars.

obtained from 5 females, and all within a seven-day collection period. Each of 20 bags received 15 eggs. The bags were kept together on a large table away from direct sunlight, their positions on the table were changed frequently. Each bag received a code number. Room temperature was recorded daily during mid-morning. Foodplant was changed every four days and body lengths of caterpillars were measured usually every two days. Head capsules were always collected and stored separately for

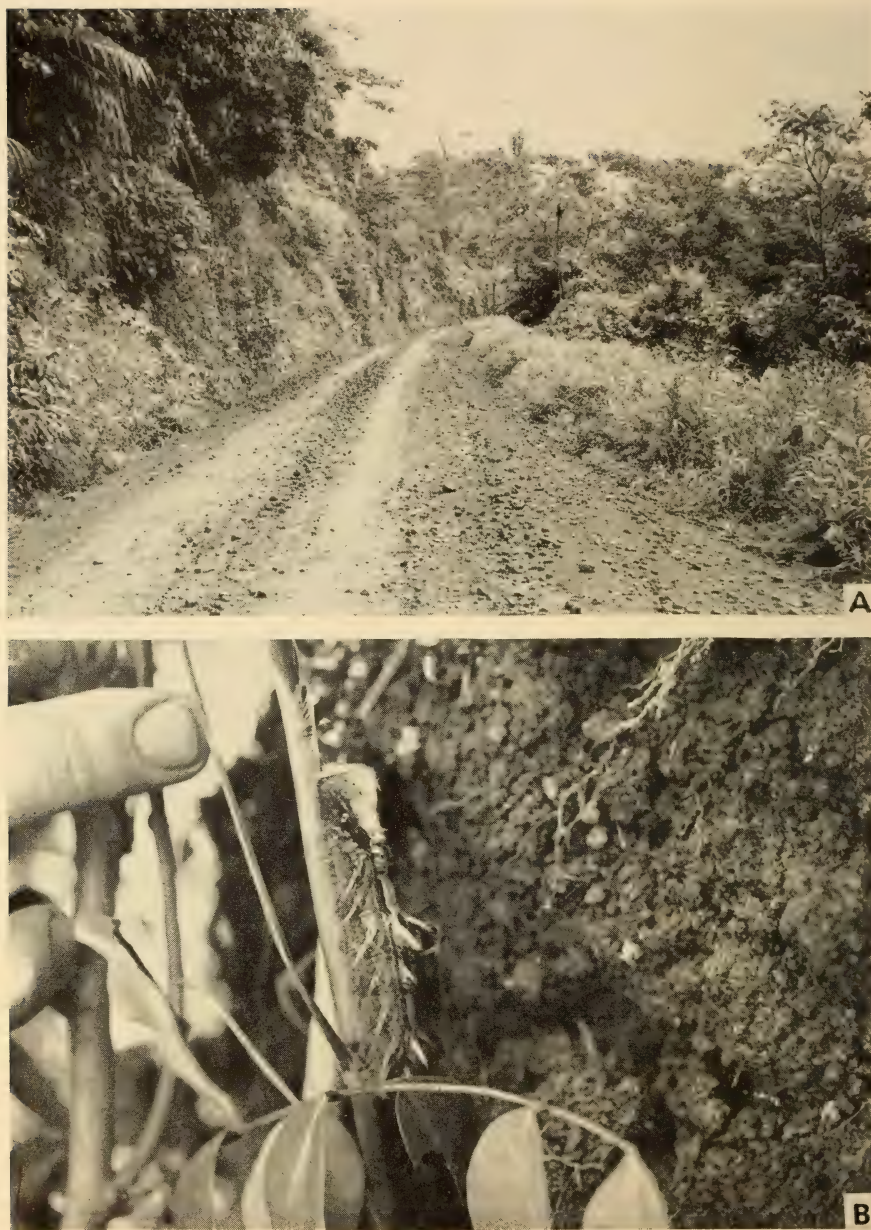


Fig. 3. Second-growth habitat of *Morpho peleides* at Cuesta Angel in Costa Rica (montane tropical forest): (A) high infestations of the caterpillars are frequently encountered on second-growth leguminous genera such as *Mucuna* and *Machaerium* which are very abundant along the sides of the road cut; (B) fifth-instar caterpillar in its cryptic resting position on a dead grass stem next to a *Machaerium* plant (16

TABLE 2. A summary of some records for caterpillar foodplants in the genus *Morpho*.

Species	Localities	Foodplants			Sources
		Genera	Families		
<i>M. peleides</i>	Costa Rica	<i>Mucuna</i> , <i>Machaerium</i>	Leguminosae		Young & Muysshondt, 1973
	El Salvador	<i>Inga</i> , <i>Lonchocarpus</i>	Leguminosae		
	Trinidad	<i>Machaerium</i> , <i>Inga</i>	Bignoniaceae		
<i>M. achilles</i>	Brazil	<i>Paragonia</i>	Leguminosae		d'Aranjo e Silva, 1968
		<i>Platymiscium</i>	Leguminosae		
		<i>Machaerium</i> , <i>Dalbergia</i>	Leguminosae		
<i>M. laertes</i>	Brazil	<i>Pterocarpus</i> , <i>Myrocarpus</i>	Leguminosae		Otero, 1971
		<i>Machaerium</i> , <i>Inga</i>	Leguminosae		
		<i>Luehea</i>	Tiliaceae		
<i>M. catenarius</i>	Brazil	<i>Acacia</i> , <i>Inga</i>	Leguminosae		d'Aranjo e Silva, 1968
		<i>Gymnanthes</i>	Euphorbiaceae		d'Aranjo e Silva, 1968
		<i>Scutia</i>	Rhamnaceae		d'Aranjo e Silva, 1968
		<i>Erythroxylum</i>	Erythroxylaceae		d'Aranjo e Silva, 1968
		<i>Cupania</i> , <i>Ratonia</i>	Sapindaceae		d'Aranjo e Silva, 1968
		<i>Pavonia</i>	Sapindaceae		Young & Muysshondt, 1972
		<i>Erythroxylum</i>	Erythroxylaceae		d'Aranjo e Silva, 1968
<i>M. anaxibia</i>	Brazil	<i>Nectandra</i>	Lauraceae		d'Aranjo e Silva, 1968
		<i>Clusia</i>	Guttiferae		d'Aranjo e Silva, 1968
		<i>Eugenia</i>	Mrytaceae		d'Aranjo e Silva, 1968
		<i>Ficus</i>	Moraceae		d'Aranjo e Silva, 1968
		<i>Erythroxylum</i>	Erythroxylaceae		d'Aranjo e Silva, 1968
		<i>Abuta</i>	Menispermaceae		d'Aranjo e Silva, 1968
		<i>Abuta</i>	Menispermaceae		d'Aranjo e Silva, 1968
<i>M. aegae</i>	Brazil	<i>Bambusa</i> , <i>Chusquea</i>	Gramineae		d'Aranjo e Silva, 1968
		<i>Merostachys</i>	Gramineae		
<i>M. portis</i>	Brazil	<i>Chusquea</i>	Gramineae		d'Aranjo e Silva, 1968

each bag. One half of the bags received *Mucuna* and the remaining ten received peanut. General day-to-day husbandry of the cultures also included removal of fecal material, dead caterpillars (recording the date of death), and periodic wiping of excess condensation. Three trained people performed the "sampling" of caterpillars and general husbandry, but the same person seldom sampled the same six or seven bags on two consecutive dates. Caterpillars were transferred as active prepupae to sturdy potted plants for pupation. Pupae were kept under the same room conditions as caterpillars and eclosion dates were recorded. Pupal size (length and width), but not weight, was recorded. Pupae of peanut-reared individuals were kept separate from those of *Mucuna*-reared individuals. The wing-span of all emerging adults was also recorded.

The same procedures were used for the subsequent study at Lawrence University, with the exception of a reduction in the number of caterpillars studied. There were 125 caterpillars reared on *Mucuna* and 100 caterpillars reared on peanut (seeds obtained from Olds Seed Co., Madison, Wisconsin). The cultures (Fig. 2) were kept in an air-conditioned laboratory whose mid-morning temperatures ranged from 21.8 to 24.0°C. The eggs used to establish the Lawrence cultures were obtained from four

August 1972). Note: As of late March 1973, this section of road cut has been drastically widened by bulldozers, destroying a great deal of available roadside foodplants for *Morpho*.

females captured in Costa Rica and brought to Appleton within a few days; the eggs were laid over an eight-day period. Prior to this time, thriving cultures of both peanuts and *Mucuna* (seeds brought from Costa Rica) were established at Lawrence for the sole purpose of rearing *peleides* and other *Morpho*.

RESULTS

In the original pilot study, all of the caterpillars of *peleides* completed development successfully, but all of the *polyphemus* caterpillars died during the late fifth instar. Developmental time was not followed carefully in this study.

In the two major studies, there were no differences in the performance of caterpillars of *M. peleides* on *Mucuna* and peanuts (Table 1). Caterpillars are apparently equally viable on both foodplants in the first generation. The various measurements given in Table 1 are adequate indicators of performance for caterpillars and pupae. The size range of adults reared on the two plants was very similar with no consistent trends towards increased (or decreased) wingspan on either plant. Very interesting is the similar success in rearing *peleides* in Costa Rica and Wisconsin (Table 1). Again, there were no consistent trends in the data supporting the view that rearing was more (or less) successful at either place. There was also no difference in the number of eggs in the bodies of virgin females reared on either foodplant: *Mucuna*-reared females less than two days old contained 61 ± 7.5 ($N = 55$) eggs and peanut-reared females contained 60 ± 5.8 ($N = 46$). Duration of older instars and the sizes of caterpillars and pupae were less variable for peanut-reared individuals (Table 1).

Wild-caught healthy females in captivity will not lay eggs on peanut leaves while the same females will readily lay many eggs on *Mucuna* leaves under the same conditions. An attempt to obtain oviposition on peanut from peanut-reared mated females has not been done since I have been unable to achieve successful mating of *peleides* in captivity.

In the pilot study on foodplant acceptance with Wisconsin legumes, it was found that second instar larvae readily accepted and survived on both *Robinia* and *Gleditsia*. This very interesting preliminary result will prompt me to conduct a large-scale controlled rearing study using several Wisconsin trees in the future.

DISCUSSION

A representative portion of the known foodplants for the caterpillars of Central and South American (Brazilian) *Morpho* is given in Table 2. If we assume for the moment that *Morpho* and flowering plants evolved

at about the same time, the caterpillar-foodplant radiation of the genus can be discussed in a speculative but interesting manner. Based on present fragmentary knowledge of foodplants used by *Morpho* (Table 2), I propose that there were several different adaptive radiations within the genus, but that one of these was far greater than the others. Borrowing from the recent phylogenetic scheme of flowering plant evolution discussed in Takhtajan (1969), the several "minor" foodplant radiations of *Morpho* included the families (in parentheses; see Table 2) in these orders: Ranunculales (Menispermaceae), Laurales (Lauraceae), Theales (Guttiferae), Urticales (Moraceae), Euphorbiales (Euphorbiaceae), and Poales (Gramineae). But it is the derivative orders of the Saxifragales that formed the major basis for foodplant radiation in *Morpho*. The following orders and families very close to, or derived from, the Saxifragales (according to Takhtajan, 1969) contain foodplants of several *Morpho* (Table 2): Fabales (Leguminosae), Sapindales (Sapindaceae), Mrytales (Mrytaceae), Geraniales (Erythroxylaceae), and Rhamnales (Rhamnaceae). No other clear pattern of foodplant exploitation exists for *Morpho* since the minor groups are scattered across the phylogenetic scheme. Of course, this may be an artifact of the scheme proposed by Takhtajan; but departures would be minor and the same general pattern should result. Also note that the Rurales (which contains Rutaceae) are also derived from Saxifragales; in March 1973, I discovered several second instar larvae of *peleides* feeding on a vine in the Rutaceae in the understory of a small semideciduous wet forest in Guanacaste, Costa Rica. Since the plant specimen was sterile, no further identification was made. These comments on foodplant radiation assume that the larval foodplant records of *Morpho* are accurate at the family level. It may be beneficial to re-check in the field some of the scattered records, especially ones like Moraceae and Euphorbiaceae (Table 2).

Thus it emerges that some species of *Morpho*, including members of the *achilles* complex (which includes *peleides*) not only feed on Leguminosae, but may in fact be preadapted to exploit other genera and species within this family. The data presented here for *peleides* on peanuts bear this out, if we assume that peanuts are not in fact used as foodplant in the wild. Such a preadaptation could result in species like *M. peleides* feeding on peanuts and other legumes. Being herbaceous, peanuts may, in fact, be an easier foodplant for digestion by caterpillars, as suggested by the reduction in the variability of developmental time and size during the ontogeny of *M. peleides* on this plant. This may be due to greater consistency of the leaves in this annual plant. In the wild, even very young caterpillars of *M. peleides* are found on very old and tougher leaves of foodplants (Young & Muyschondt, 1973). That *M. peleides* in

particular may be especially preadapted for the exploitation of many different legumes is also suggested by the large number of foodplant species and genera that this species is found on locally in second-growth plant communities in Costa Rica. Here, the caterpillars are generally found on a variety of leguminous vines and small shrubs even along road sides where young second-growth is frequently encountered (Fig. 3). As with peanuts in the laboratory, the developmental time and size range of individuals reared on these different natural foodplants are very similar (Young & Muysshondt, 1973), indicating that the species performs equally well on all of these plants. If we assume that the deaths of the *M. polyphemus* caterpillars feeding on peanuts in the small pilot study was due to some metabolic or physiological incapacity to handle this food properly, it is possible that this species is less preadapted for generalized leguminous feeding than *M. peleides*. Partial support for this idea comes from the known foodplant data for *M. polyphemus* in El Salvador, and its close relative, *M. catenarius*, in Brazil (Table 2). The majority of foodplants are not legumes (Table 2) and these butterflies may have followed a different evolutionary path for foodplant exploitation from that of *M. peleides* and its close relatives. Of course, the data here for *M. polyphemus* are very preliminary and more extensive rearing tests on peanuts must be performed to demonstrate reduced performance on this plant. In light of these preliminary findings and their implications concerning evolutionary divergence in caterpillar foodplant exploitation, it could be very interesting to conduct similar rearing studies of other generally non-leguminous feeders of Brazilian *Morpho* (*anaxibia*, *menalaus*, *hercules*, *aega*, etc.—Table 2) with peanuts.

SUMMARY

(1) Caterpillars of the neotropical butterfly, *Morpho peleides* were reared in Costa Rica and Appleton, Wisconsin on *Mucuna urens* (a known natural foodplant) and peanuts, *Arachis hypogaea*, under identical conditions. While both plants are in the Leguminosae, the assumption was made that peanuts would be a novel foodplant for this butterfly since no records of it feeding on peanuts in tropical America are known. Furthermore, all of the known leguminous foodplants of the butterfly are woody perennials and not herbaceous annuals.

(2) Using various measures of performance such as egg-adult developmental time and body size, it was found that caterpillars were equally viable on either plant. There was less variability in performance among caterpillars reared on peanuts.

(3) A pilot study of rearing caterpillars of *Morpho polyphemus* on peanuts showed that they succumb in the fifth instar. But since a very

small number of caterpillars were studied, it could not be determined if these deaths were accidental or actually due to improper handling of the food by the digestive machinery of the caterpillars. This species in the wild feeds primarily on a variety of non-leguminous foodplants and it may eventually be shown that the caterpillars are less conducive to leguminous feeding.

(4) Based on foodplant records and the phylogeny of flowering plants, it is speculated that the major adaptive radiation of *Morpho* occurred on plant families within various orders close to, or derived (in evolutionary time) from, the Saxifragales. Of these orders and families, the major array of foodplant exploitation is in the Leguminosae, a member of the Fabales.

(5) The idea is advanced that *M. peleides* is preadapted to feed on many genera and species of legumes locally and there are some field data to support this view (Young & Muyschondt, 1973). Other legume-feeding species support this view (Young & Muyschondt, 1973). Other legume-feeding species of *Morpho* may show similar ecological flexibility while generally nonleguminous feeding species may not.

ACKNOWLEDGMENTS

This research was supported by a grant from the Bache Fund of the National Academy of Sciences (No. 120), and partially by National Science Foundation Grant GB-33060. Logistic support in Costa Rica was provided by the Costa Rican Field Studies Program of the Associated Colleges of the Midwest (A.C.M.). Roger Kimber and John Thomason (Lawrence University) assisted with the rearing studies. Keith S. Brown, Jr., and Woodruff W. Benson read a revised version of the manuscript and made several helpful suggestions.

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THE PROPER SUBSPECIFIC NAME FOR *SPEYERIA APHRODITE*
(NYMPHALIDAE) IN SOUTHWEST MANITOBA

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The most recent revision of the genus *Speyeria* (dos Passos & Grey, 1947) and the most recent checklist for Nearctic butterflies (dos Passos, 1964) have designated the southwest Manitoba population of *Speyeria aphrodite* (Fabricius) as subspecies *mayae* (Gunder). The name *mayae*, as proposed by Gunder, is unavailable and the name *manitoba* (Chermock & Chermock) must be used instead.

Jean D. Gunder described *mayae* (1932) as *Argynnis aphrodite cypris* transitional form *mayae* from a pair of specimens collected by Marjorie May at Sand Ridge, Manitoba. Under the provisions of the International Code of Zoological Nomenclature (1961), this name is unavailable as a species group name because it was proposed as a quadrinomial and because the author's intent was to describe an aberrant form and not a subspecies. Gunder coined the term "transitional form" to be used to refer to those types of aberrations that he considered nameable. Gunder's holotype (Fig. 1, A & B) is a weird aberration of a sort that infrequently pops up in *Speyeria*. The Code provides, however, that although a name is unavailable when proposed, it can become available at a later date if elevated to a species group name. This was done when dos Passos & Grey (1947) elevated it to the subspecies rank. When a name is elevated in this manner it must take the date and the authorship of the elevation, in this case dos Passos & Grey 1947.

In the meantime Chermock & Chermock (1940) described *Speyeria aphrodite manitoba* from the same locality: Sand Ridge, Manitoba. Their name has priority over *mayae* dos Passos & Grey. A typical looking male of *Speyeria aphrodite manitoba* is illustrated (Fig. 1, C & D).

A very similar situation occurred with the southwest Manitoba prairie population of the *Speyeria atlantis* (Edwards) complex. Gunder (1927) described an aberrant as *Argynnis lais* tr. f. *dennisi*; this name being unavailable until being elevated by dos Passos & Grey (1947). Chermock & Chermock (1940) described *Argynnis atlantis hollandi* from nearby Riding Mountain, Manitoba. Their name, however, applies to the dark forest population of the *Speyeria atlantis* complex, and is not a subjective synonym of *dennisi*. It is my opinion that there are two species involved in what dos Passos and Grey call "*Speyeria atlantis*." The name *dennisi* is available then, but must be credited to dos Passos & Grey 1947.

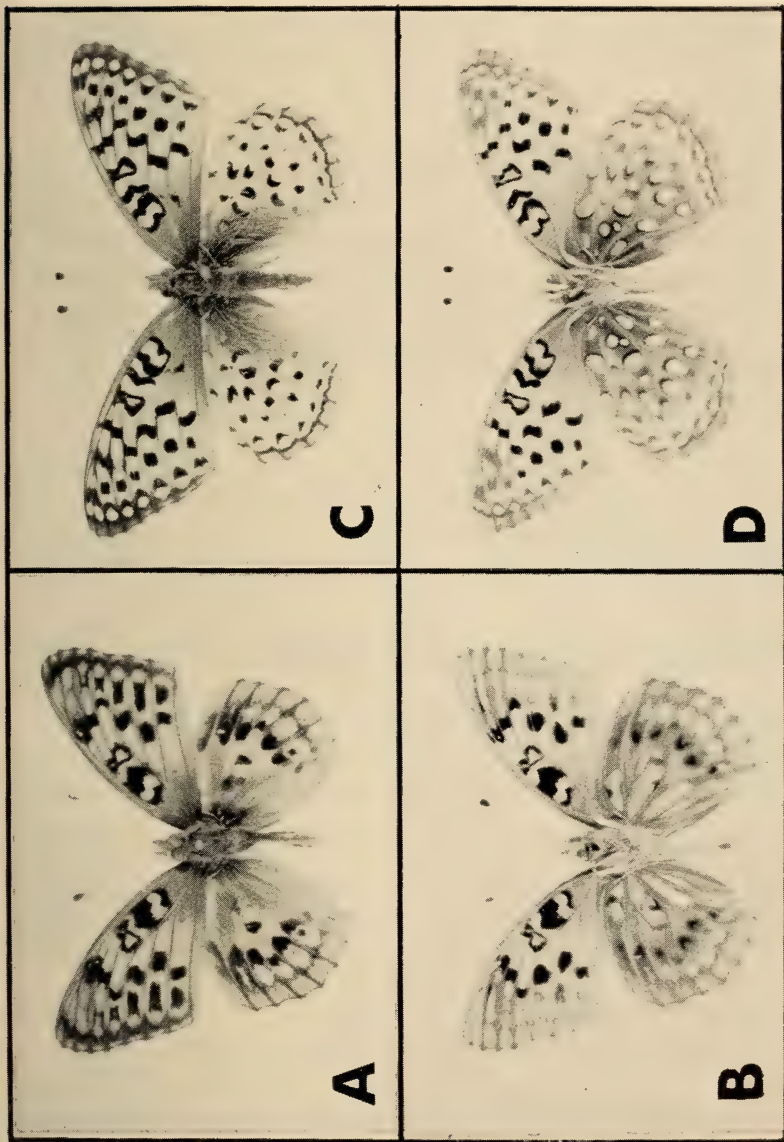


Fig. 1. Specimens of *Speyeria aphrodite*: (A) holotype male, *Argynnis aphrodite cypris* tr. f. *mayae* Gunder, "Sand Ridge" Manitoba, near Bener Dam Lake, 10 Sept. 1931, collected by Marjorie May; (B) underside of same specimen; (C) typical male, *Speyeria aphrodite manitoba* (Chermock & Chermock), Beulah, Manitoba, 14 Aug. 1939, collected by Jack Dennis; (D) underside of same specimen. Specimens are in the collection of the American Museum of Natural History, New York City. All figures actual size.

In a discussion of these butterflies described from "Sand Ridge, Manitoba" some mention should be made as to the whereabouts of Sand Ridge; a locality that is not to be found on any map. Sand Ridge was a favored collecting locality of Jack May, Vern Harper and L. P. Baker and has become the type locality for a dozen taxa in Lepidoptera. The actual site is a gravel ridge, which was formed as a beach on glacial Lake Agassiz, 8 miles east of McCreary, Manitoba. Bener Dam Lake, a rather small impoundment is here. This locality is just east of Riding Mountain and is in western Manitoba. In the past many persons have placed "Sand Ridge" in the vicinity of the town of Sandilands or the Sandilands Provincial Forest Reserve. These are both in southeastern Manitoba on the other side of the Red River Valley/Lake Winnipeg divide that separates many species of Lepidoptera into eastern and western subspecies. It is very important then that anybody working with taxa described from Sand Ridge understand exactly where it is.

ACKNOWLEDGMENT

I am grateful to Dr. F. H. Rindge of the American Museum for allowing me to examine specimens of the former Gunder collection, now a part of the American Museum collection in New York City.

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GEOGRAPHICAL DISTRIBUTION OF HOSTPLANT CHOICE
IN *EUPHYDRYAS EDITHA* (NYMPHALIDAE)

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An investigation of populations of *Euphydryas editha* Boisduval reveals a disjunct distribution of foodplant choice (Fig. 1). *Euphydryas editha* may oviposit on plants of at least five genera: *Collinsia*, *Castilleja*, *Pedicularis*, *Orthocarpus* (Scrophulariaceae), and *Plantago* (Plantaginaceae). With rare exceptions, only a single plant species is selected in each population, even though plants that are selected elsewhere may be abundant. This parallels observations of Downey & Fuller (1961) on *Plebejus icarioides* Boisduval. We have visited as many *Euphydryas* populations as possible, identifying primary hostplants of 50 by observing oviposition or by locating eggs or webs of prediapause larvae. Post-diapause larvae may move onto secondary foodplants and may even prefer these to primary hosts (Table 1). Oviposition preference in the laboratory is not necessarily the same as that in the field, and cannot always be used as positive evidence for placing a population in a particular foodplant category.

Our present knowledge of the distribution of hostplant choice (mostly in California) is summarised in Fig. 1. Though it is difficult to separate cause and effect, there are strong correlations between plant species chosen and a) timing of flight season, and b) type of community inhabited. Early-flying, coastal populations are *Plantago*-feeding, with some oviposition on *Orthocarpus* (EW, WS) and fewer on *Collinsia* (CS). Low altitude, late-flying populations in the chaparral belt of the Inner Coast Ranges are all on serpentine soils and utilise *Pedicularis densiflora* Benth. ex Hook. (plant identifications follow Munz & Keck, 1959). Very close to a number of *Pedicularis*-feeding populations, but on a scree at 6900 feet in elevation in Mendocino County there is a single population (HM) feeding on a small and rather scarce annual, *Collinsia greenei* Gray. At similar elevations of the Sierra Nevada and in the San Bernardino Mountains we have records of small *Collinsia* species being utilised: *C. childii* Parry ex Gray at CP, *C. callosa* Parish at WK, and *C. parviflora* Dougl. ex Lindl. on both the east (SN) and the west (SL) slopes of the Sierra. It seems likely (S. O. Mattoon, pers. comm.) that

TABLE 1. Primary and secondary foodplants of some *E. editha* populations.

Population	Oviposition plants in order of importance	Secondary prediapause foodplants	Postdiapause foodplants in order of importance
JR	<i>P. erecta</i>	<i>O. densiflorus</i>	<i>P. erecta</i> <i>O. densiflorus</i>
EW	<i>O. densiflorus</i> <i>P. erecta</i>		<i>O. densiflorus</i> <i>P. erecta</i>
LO	<i>P. insularis</i> <i>P. hookeriana</i>		<i>P. insularis</i> <i>P. hookeriana</i> *
DP	<i>P. densiflora</i> <i>C. bartsiaefolia</i>		<i>P. densiflora</i> <i>C. foliolosa</i> <i>C. affinis</i> <i>C. bartsiaefolia</i>
CP	<i>C. childii</i>		<i>C. childii</i>
WK	<i>C. callosa</i>		<i>C. callosa</i>
SN	<i>C. parviflora</i> <i>P. lanceolata</i>		<i>C. parviflora</i> <i>P. lanceolata</i>
SL	<i>C. parviflora</i>		<i>C. parviflora</i> <i>P. semibarbata</i>
GH	<i>P. semibarbata</i>		<i>P. semibarbata</i>
MC	<i>C. tinctoria</i>		<i>C. tinctoria</i> <i>C. sparsiflora</i> <i>Lonicera interrupta</i> <i>Plectritis ciliosa</i> *
IF	<i>C. tinctoria</i>		<i>C. tinctoria</i>
GL	<i>C. nana</i>		<i>P. heterodoxus</i> <i>C. nana</i>
TM	<i>C. nana</i>		<i>C. nana</i>

* Order of importance may vary from year to year.

populations of this type occur widely in Lassen and Shasta counties. In the southwestern Sierra these *Collinsia*-feeding populations are interspersed with colonies in the same general habitat (coniferous forest clearings; sandy, granitic soil) in which *Pedicularis semibarbata* Gray is utilised (GH, BM). Both *P. semibarbata* and *C. parviflora* are common and well distributed, but *E. editha* populations seem to be few and widely scattered at these altitudes. Thus, as with *P. densiflora* in the Inner Coast Ranges, the distribution of *E. editha* is not limited by the distribution of its larval foodplants.

At lower altitudes (1000-4000 ft.) in the western Sierra is a N-S belt of *E. editha* populations which are hostplant specific for *Collinsia*

tinctoria Hartw. ex Benth., rejecting even other *Collinsia* species where these are present (*C. sparsiflora* F. & M. at MC, and *C. sp.* at IF).

Finally, at high altitudes (8000–11,500 ft.) along the crest of the Sierra we have found oviposition on *Castilleja nana* Eastw. to be the rule. At one of these populations (EP) we found another case of rejection of a congeneric plant, *Castilleja breweri* Fern. At EP, *C. breweri* is as abundant as *C. nana* and grows intermingled with it, but is not used for oviposition.

Although the geographical range of *E. editha* extends from British Columbia to Baja California and eastwards to Colorado, Wyoming, and Alberta, we have little information on foodplant choice outside of California. In eastern Nevada we found two populations approximately three miles apart. In one of these, at 8000 ft. in a Pinon-juniper community, *Pedicularis centranthera* is the foodplant, while in the other, at 11,000 ft., oviposition is on *Castilleja lapidicola*. In the McDonald Forest, near Corvallis, Oregon, we found postdiapause larvae feeding on the common weed, *Plantago lanceolata* L., in clearings of coniferous forest. We have been informed (D. V. McCorkle, pers. comm.) that this Eurasian import is also utilised for oviposition.

We suspect that, even for California, the pattern of foodplant choice we describe here is incomplete. We have been unable to locate eggs or larvae of *E. editha* at a number of California populations where adults are well known, notably Parkfield Summit (Fresno-Monterey county line), Gold Lake (Sierra County), Bishop Creek (Inyo County), and Mather (Tuolumne County). Furthermore, several museum records of *E. editha*, such as those from eastern San Diego County, seem not to fit into any of the categories we have described.

These data indicate that conclusions about foodplant relationships of an entire species of herbivorous insect should be made with caution when they are based on study of one or a few populations. Furthermore, since other aspects of the ecology of the insect, such as population dynamics, may be influenced by its choice of foodplant (White, 1973), these types of investigation also should ideally proceed on a population basis until a general pattern emerges. The lack (or complexity) of pattern in our data (Fig. 1) emphasizes the importance of evolution at the population level in the strategy of *E. editha*. Such evolution has allowed rapid exploitation of new food resources, such as the imported *Plantago lanceolata* and *Plantago insularis* Eastw. (Bassett & Baum, 1969) as they have become available. This exploitive ability stems from the high reproductive potential of *E. editha* (Labine, 1968) and the low frequency of oviposition on alternative foodplants coupled with the ability to utilise these plants in response to selection. The hypothesis

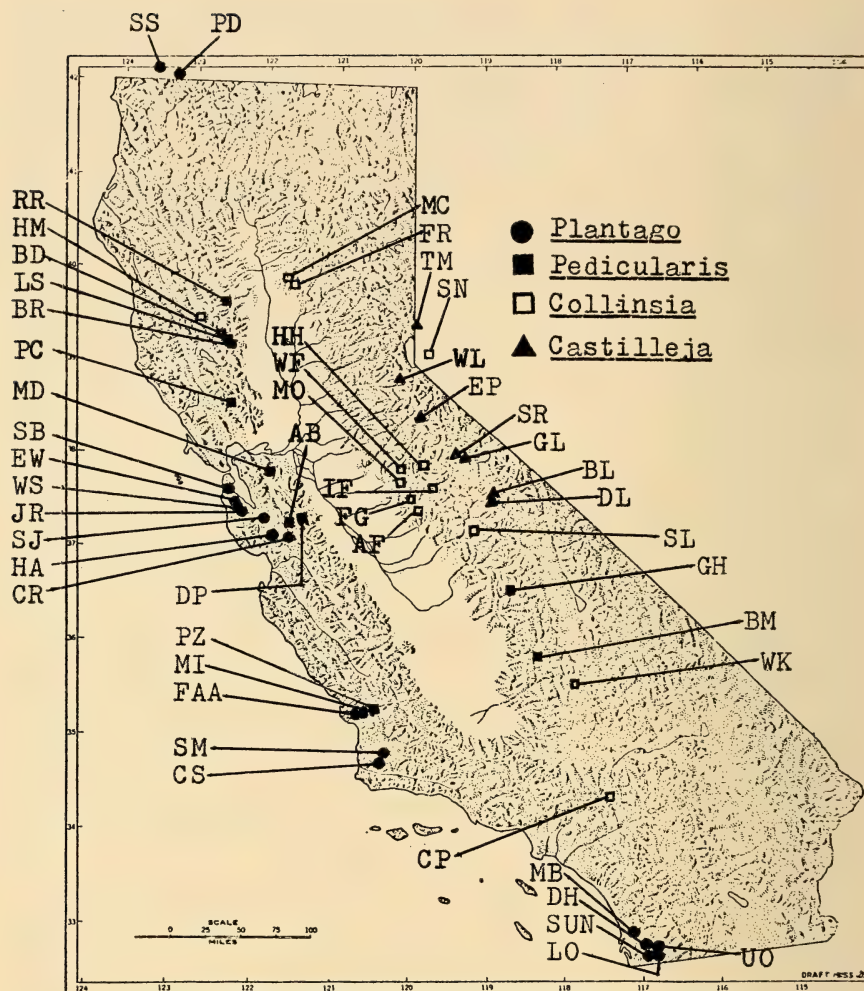


Fig. 1. *Euphydryas editha* populations designated by their code initials. The symbols superimposed on this map of California represent the location and the larval foodplant of each population.

that the range of plants acceptable to a migrant female *E. editha* broadens with increasing oviposition motivation as she searches (Singer, 1971) would, if true, explain how a population can be founded on a foodplant which would not have been utilised in the parent population even if present.

Since there is no simple correlation between primary hostplant used by an *E. editha* population and the subspecies to which the population

would be assigned, we propose to discuss the relationships between ecology and taxonomy of the insect in a separate paper.

ACKNOWLEDGMENTS

We would like to gratefully acknowledge aid, particularly in pinpointing *E. editha* population locations and flight times, from the following people: Ralph Wells, Fred Thorne, J. Tilden, William Swisher, Michael Smith, Oakley Shields, Harriet Reinhard, Paul Opler, James Mori, Andrew Moldenke, David McCorkle, Sterling Mattoon, Chris Henne, Lawrence Gilbert, Clifford Ferris, Thomas Emmel, Paul R. Ehrlich, Helen Cox, and David L. Bauer. This work was supported by NIH traineeships 000-365-06 through 000-365-11; NSF grants GB 8038, 8174, 19686, 22853, and 35259; and by a grant from the Ford Foundation.

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THE BIOLOGY OF *PAPILIO INDRA NEVADENSIS* (PAPILIONIDAE) IN NEVADA

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In the late 1960's, a new race of *Papilio indra* Reakirt was discovered in at least two isolated mountain ranges of the Great Basin state of Nevada. Described by Emmel & Emmel (1971), *Papilio indra nevadensis* is differentiated in the adult stage from all other known

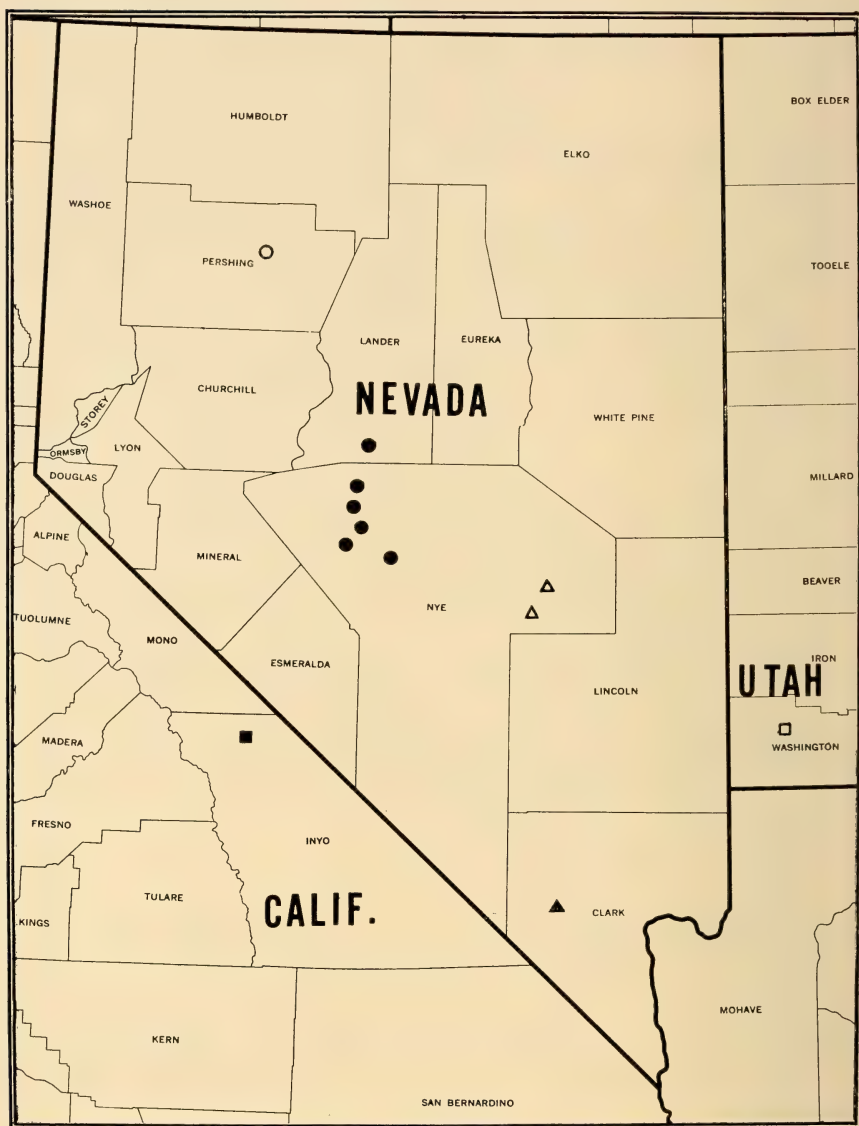


Fig. 1. Map of the known distribution of *Papilio indra nevadensis* Emmel & Emmel, including closely related segregates in Nevada, California, and Utah referred to in the text. The central area in Lander and Nye counties is the Toiyabe Range referred to in the text. ● — closed circles = *nevadensis* populations in the Toiyabe Range and Toiyabe Range; ○ — open circle = Humboldt Range, Pershing Co., population; ■ — closed square = Westgard Pass, Inyo Co., California, population; □ — open square = Pine Valley Mountains, Washington Co., Utah, population; △ — open triangles = Grant Range and Quinn Canyon Range, Nye Co., populations; ▲ — closed triangles = Spring Mountains, Clark Co., population.

indra subspecies by the character combination of a wide postmedian yellow band on the forewing and hindwing, long tails, large size and elongated wings. The purpose of the present paper is to describe the distribution, habitat, behavior, foodplants, and life history of this distinctive Nevada subspecies.

Distribution, Habitat, and Habits

Papilio indra nevadensis has been found in fair numbers in a series of canyons (especially Jett, Kingston, Peavine Creek, Summit, and Twin River Canyons) along the east side of the Toiyabe Range in Nye and Lander counties, Nevada. It also occurs to the east in the Toquima Range (Nye Co.) which runs parallel to the Toiyabe Range. Peter J. Herlan of the Nevada State Museum has taken two *P. indra* specimens in the Humboldt Range, Pershing Co., which represent either spring brood specimens of *nevadensis* or a population intermediate in adult characters between typical *indra* and *nevadensis*. This mountain range is approximately 100 miles NNW of the Toiyabe Range.

To the west of the Toiyabe Range, at Westgard Pass at the south end of the White Mountains in Inyo Co., California, a *P. indra* population is found which appears intermediate between *nevadensis* and typical *indra*. It utilizes the same *Pteryxia petraea* foodplant as *nevadensis*.

Southeast of the Toiyabe Range, several *P. indra* segregates which show a close affinity to *nevadensis* have been studied. *P. indra* larvae were collected on *Lomatium parryi* (Wats.) Macbr. (Umbelliferae) in the Grant Range and Quinn Canyon Range, Nye Co., in 1969, but the resulting pupae died, so the adult phenotype of these populations is not known. The coloration of these larvae appeared closest to that of *P. i. martini*. Farther south, in the Spring Mountains of Clark Co., adults and immatures of *P. indra* have been collected which show characters of both *nevadensis* and *martini*. The adults of this population are large with elongated wings as in *nevadensis*. The postmedian band of yellow spots tends to be intermediate in width between that of *martini* and *nevadensis*, and on the secondaries it tapers posteriorly as in *martini*. The color pattern of larvae from the Spring Mountains appears to be closest to that of *martini*.

Another atypical *P. indra* segregate is found in the Pine Valley Mountains in extreme southwestern Utah. Adults and larvae of this population seem closest to those of the Spring Mountains' populations. However, pupae from this locality are closest to those of *P. i. kaibabensis*.

The locations of these populations are shown on the accompanying map (Fig. 1).



Figs. 2-5. Habitat and foodplants of *Papilio indra nevadensis*: 2-3, Jett Canyon, from the east side of the Toiyabe Range, Nye County, Nevada; 4, canyon wall with scattered *Pteryxia* plants at Jett Canyon; 5, *Pteryxia petraea* at Kingston Canyon in the Toiyabe Range, Lander County, Nevada.

The typical semi-arid, lower montane habitat where *P. i. nevadensis* occurs is exemplified by the Jett Canyon area in the Toiyabe Range. This canyon is located on the eastern slope near the southern end of the range (Fig. 2). The entrance to the canyon is very narrow, with steep walls on both sides of the narrow, 4-wheel-drive road going up the defile. The Canyon bottom is well watered by a permanent stream (Fig. 3). Typical vegetation within the canyon includes pinyon pine, willows (*Salix exigua* Nutt.), sagebrush (*Artemisia tridentata* Nutt.), *Prunus virginiana* L. var. *demissa* (Nutt.) Sarg., *Purshia tridentata* (Pursh) DC., and *Holodiscus boursieri* (Carr.) Rehd. The umbelliferous foodplants of this butterfly grow on the steep, rocky slopes and canyon walls (Figs. 4, 5).

At present, we have only scant data regarding the spring brood. Based on our observations of immatures in June and July, we suspect that the spring brood flies in late May and June. The size of the summer brood is variable; in 1967, 25 adults were collected in Jett Canyon in one day in August. In 1968, no adults were seen when the area

was visited on 10 August, while on 3 August 1969, only one adult was taken.

Males were taken feeding on *Cirsium* species (thistles) and at mud or wet sand, and occasionally they visited blooms of *Clematis* vines. Females frequented *Cirsium* flowers and one was observed feeding on a *Convolvulus* (morning glory); several were flying along the canyon bottom. Other *Papilio* species actively flying at this time in these Toiyabe Range canyons are *P. zelicaon* Lucas, *P. bairdii bairdii* Edwards and *P. b.* form *brucei* Edwards, *P. multicaudatus* Kirby, and *P. rutulus* Lucas. Only the first species uses the same larval foodplant as *P. i. nevadensis*.

The altitudinal span inhabited by *P. i. nevadensis* in the Toiyabe Range is 6200 to at least 7200 ft., with most specimens being taken between 6300 and 6800 ft. Undoubtedly hilltopping males ascend to the highest peaks of the Toiyabes, which are over 11,000 ft.

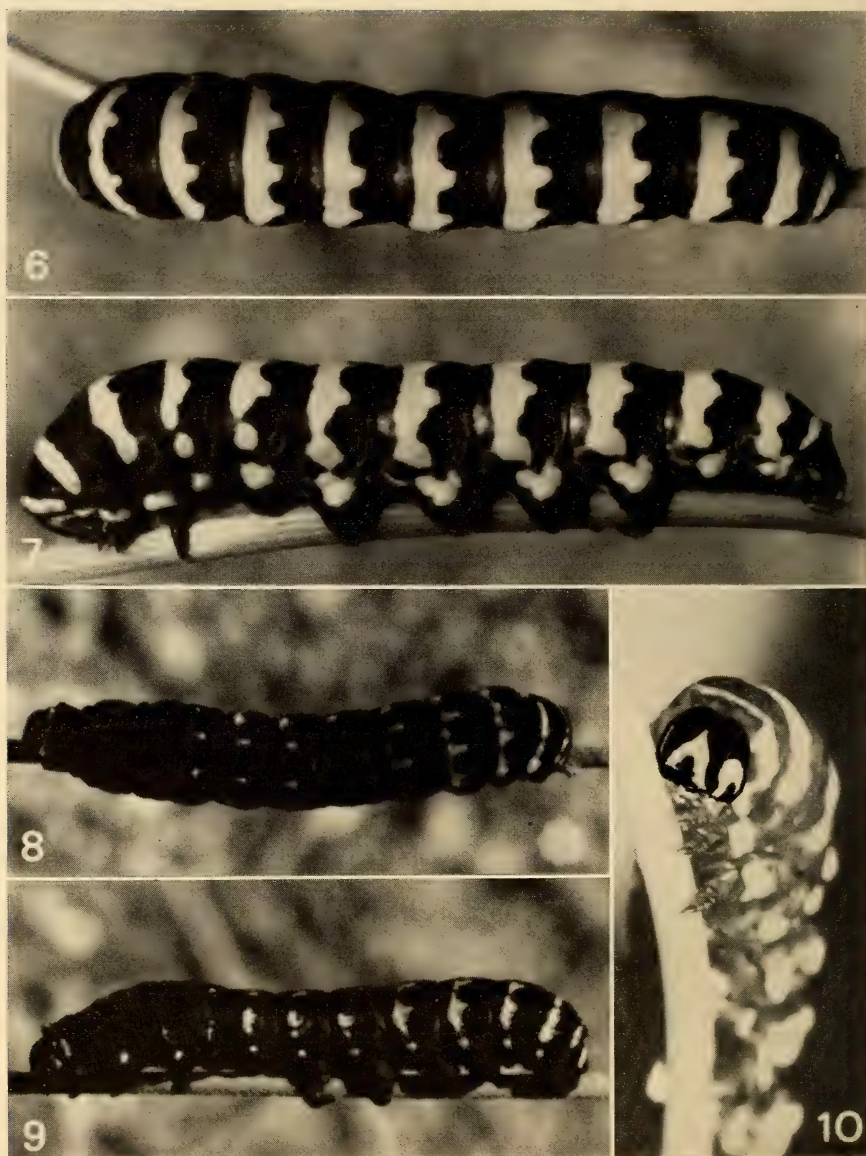
Foodplant and Life History

Throughout the Toiyabe Range and in the Toquima Range in central Nevada, *Papilio indra nevadensis* uses *Pteryxia petraea* (Jones) C. & R. (Umbelliferae) as a larval host. Females have been observed to oviposit on these plants in the field, and larvae of all five instars have been found on the *Pteryxia* in these mountain ranges. *Pteryxia petraea* is also found in the Humboldt Range, Pershing County, and doubtless serves as the foodplant for the *P. indra* population there.

Egg: Globular in shape, smooth, about 1 mm. in diameter, and creamy white; laid singly on underside of foodplant leaf. Early instars black with white and light orange or yellow markings and closely resembling those of *P. i. minori* and *P. i. kaibabensis*.

Fifth-instar Larva: Length: 40–45 mm. at maturity. Head: Width of head capsule, 4.0 mm. Head capsule pattern in most examples (Fig. 10) distinct from patterns of all other *P. indra* subspecies. Ground color black. Inverted "V" of light orange occurs on adfrontal margins, and low inverted "U" of similar color occurs laterally. On *P. i. indra*, *minori*, *kaibabensis*, and *pergamus*, these lateral marks extend dorsally to or near to top of head capsule. In *P. i. martini* and *fordi*, they are absent.

Body (Figs. 6–9): Ground color black. In more common morph, each segment with narrow transverse cream colored band with pinkish tint, of a width covering two-thirds of anterior half of segment (not all the way to anterior edge) and ending on either side at level of spiracles (thoracic segments) or well below spiracles (abdominal segments). These bands yellowish to light pink in *P. i. indra* Reakirt (see Emmel & Emmel, 1973), white to pinkish gray in *P. i. pergamus* Hy. Edwards (see Comstock, 1928, and Emmel & Emmel, 1973), white, bluish white, or pale pink in *P. i. fordii* Comstock & Martin (see Comstock & Martin, 1955, and Emmel & Emmel, 1973), dull pink or salmon in *P. i. martini* Emmel & Emmel (see Emmel & Emmel, 1968), and rich bright pink in *P. i. kaibabensis* Bauer (see Emmel & Emmel, 1967) and *P. i. minori* Cross (see Emmel & Emmel, 1964). Transverse row of six rather large, yellowish orange spots located just beyond



Figs. 6-10. Larvae of *Papilio indra nevadensis*: 6, common morph of fifth-instar larva, dorsal aspect; 7, common morph of fifth-instar larva, lateral aspect; 8, dark fifth-instar larva, dorsal aspect; 9, dark fifth-instar larva, lateral aspect; 10, head capsule pattern of fifth-instar larva, frontal view.

posterior edge of each cream colored band in dorsal, suprastigmatal, and lateral positions. Thoracic legs and prolegs black; large white patch found laterally on each proleg and at base of each of the other segments.

One very dark larva taken at Kingston Canyon (Figs. 8, 9). Here, cream bands and other patches quite whitish and reduced in size and yellow-orange spots on body very reduced (dorsal rows) or absent (suprastigmatal and lateral rows). Head capsule markings remain similar to those of lighter morph.

Pupa: Length: 25–30 mm. Greatest width at wing cases: 7–9 mm. Morphologically like those of other subspecies of *P. indra*. General ground color light dull tan, with mottling of various darker and lighter brown marks and lines over entire surface.

DISCUSSION

In the adult stage, *Papilio indra nevadensis* combines several of the key characteristics of *P. i. pergamus* (large size, elongated wings, long tails) and *P. i. fordi* (broad yellowish bands on the wings). In the original description (Emmel & Emmel, 1971), the new subspecies was said to be superficially closest to *P. i. pergamus*. Biologically, however, it differs in being double-brooded, having a generically different foodplant, and in having major larval and pupal color-pattern differences. There appear to be populations intermediate between *P. i. indra* and *nevadensis* to the north and west of the Toiyabes and intermediate between *martini* and *nevadensis* to the south. Populations in the Pine Valley Mountains in Utah show a combination of characters of *nevadensis*, *martini*, and *kaibabensis*. Thus the group of central Nevada populations that are placed under the name *nevadensis* represent a true geographical subspecies which has departed evolutionarily in both larval, pupal, and adult characters, as well as general biology, from its conspecific relatives.

SUMMARY

The distribution, habitat, behavior, life history and foodplants of *Papilio indra nevadensis* are described from field work in Nevada, particularly in the Toiyabe Range. The mature larva differs in head capsule pattern, body pattern and coloration from larvae of all other *P. indra* subspecies. The foodplant is *Pteryxia petraea* (Jones) C. & R.

ACKNOWLEDGMENTS

The present paper is part of a continuing study of evolution in populations of the *Papilio machaon* complex in North America. We thank the Allyn Museum of Entomology and the Los Angeles County Museum of Natural History for travel funds from 1967 through 1969. Completion of this research was aided by National Science Foundation Grant GB-32151 as part of a study on chromosome evolution in

Lepidoptera. Peter J. Herlan of the Nevada State Museum and his wife Barbara assisted greatly during field work in Nevada. Oakley Shields and Scott Ellis assisted in field collection of material.

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FIELD OBSERVATIONS ON *COLIAS ALEXANDRA* EDWARDS (PIERIDAE)

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In recent years there has been vigorous interest in all aspects of the biology of North American species of *Colias*. *Colias alexandra* Edwards, a widespread species of the western foothills and mountains has attracted increased attention. Hovanitz (1950a) described its distribution, and (1950b) plotted frequencies of the dimorphic females. Ae (1959) induced laboratory crosses between *C. alexandra* and *C. eurytheme* Boisduval. Masters (1970) and Ferris (1972, 1973) examined the taxonomy of the species. John M. Burns (unpubl.) has studied the electrophoretic variation of esterase in different *Colias* species, including *alexandra*. An attempt is made here to augment this work with notes on foodplants, population structure, and behavior in *Colias alexandra*. Observations were made on 35 *C. alexandra* populations during 1971 and 1972 in Colorado, Utah, Nevada, Idaho, and Montana.

Colias alexandra is widely distributed along the axis of the Rocky

Mountains from New Mexico to Alberta and British Columbia, with outlying populations to the west in the Great Basin areas of Utah, Nevada, Idaho, eastern California, and then northward into eastern Oregon and Washington. East of the Rockies isolated populations occur in western Nebraska and the Black Hills of South Dakota. If *christina* Edwards is accepted as a subspecies of *alexandra*, the range is extended northeastward from Montana to Manitoba and northward to the Yukon River to approximately 67°N. For a distribution map and current taxonomic treatment, see Ferris (1973). *C. alexandra* is found in dry, open associations of the Transition and Canadian zones, most frequently from 7500–9000 ft. in the Colorado Rockies to 2000 ft. in northern Idaho.

Oviposition Records. Edwards (1897) lists *Thermopsis* (Leguminosae) and *Astragalus* (Leguminosae) as natural foodplants. He found clover *Trifolium repens* L. (Leguminosae) to be a satisfactory laboratory host. Edwards received *alexandra* ova from several workers in Colorado. Edwards noted in his entomological journals that he received *alexandra* ova on 27 July 1884 laid on *Astragalus* from Nash at Rosita, Wet Mtns., Custer Co., Colorado. He also received eggs from Prof. G. H. French at Central City, Gilpin Co., laid 27 July 1886 on *Thermopsis*. Edwards (1873) reports that Mead observed *alexandra* ovipositing on *Lupinus* (Leguminosae) in the northern part of South Park, probably in present-day Park Co., Colorado. From my experience with *alexandra* over much of its range, it appears that members of *Lupinus* are unlikely foodplants. Mead had only limited experience with the Colorado flora at the time of his observation, and may have misidentified the foodplant. McDunnough (1922) notes an oviposition by *Colias christina* in Alberta on a "small species of lupine with a greenish-white flower." This vague description might apply to *Astragalus canadensis* L. var. *mortonii* (Nutt.) S. Watson, a foodplant for *alexandra* in northern Idaho and western Montana. Klots, in Ehrlich & Ehrlich (1961), lists *Astragalus* and *Medicago* as foodplants. Shields & Emmel (1969) observed oviposition on *Astragalus miser* Dougl. in the Wasatch Range in Sanpete Co., Utah. Ferris (1973) cites *Astragalus serotinus* as a foodplant. Barneby (1964) considers *serotinus* (Gray) a variety of *Astragalus miser*.

Unpublished oviposition records unsubstantiated by herbarium determinations include *Thermopsis pinetorum* Greene from the White Mountains, Arizona, by Kilian Roever; *Thermopsis divaricarpa* A. Nels., Rampart Range Road, NE of Woodland Park, Teller Co., Colo., by F. M. Brown (photograph of ovum on plant). No ovipositions have yet been observed on *Thermopsis montana* Nutt., a species widespread west of the continental divide in Colorado. Kearney & Peebles (1951) consider *T. pinetorum* "doubtfully distinct" from *T. montana*. Mike Fisher ob-

served oviposition on *Oxytropis lambertii* Pursh. (Leguminosae) near Parker, Douglas Co., Colorado.

Foodplant-butterfly Relationships. Repeated ovipositions on a plant species in one locality, or oviposition on the same plant species in different localities is considered here to be a strong confirmation that the oviposition plant is the foodplant. No obvious oviposition mistakes were seen. *Astragalus eremiticus* is the only foodplant listed for which there is only a single oviposition sighting.

Many members of the genus *Astragalus* and *Oxytropis* are known to accumulate toxic compounds in their systems, especially the element selenium. *Colias alexandra* oviposited on *Astragalus miser*, *A. bisulcatus*, and *Oxytropis lambertii*, which are frequently poisonous to livestock. The toxicity of *A. miser* appears to vary as a function of the selenium concentration of the many different types of soil the plant inhabits. Barneby (1964) notes that "*miser* var. *oblongifolius* is often browsed, even where innocuous feed is plentiful, at least in the Colorado Rocky Mountains." For *A. bisulcatus*, Barneby (1964) states that: "On warm days and while drying in the press, the herbage gives out a strong smell of selenium disagreeable to most people and to some actually nauseating. It is one of the most dangerous and widely dispersed of the seleniferous stock poisons." A study of the biochemical relationship between *C. alexandra* and *A. bisulcatus* might prove rewarding, particularly if selenium is metabolized and stored in the immature and adult stages of the butterfly.

The ranges of *C. alexandra* foodplants often greatly exceed the range of the butterfly. Of particular interest is the absence of *alexandra* in most parts of Arizona, especially on the Kaibab Plateau north of the Grand Canyon (Kilian Roever, pers. comm.) where varieties of *A. lentiginosus*, *A. miser*, and *A. bisulcatus* are known to occur. *C. alexandra* is known from the nearby mountains in southwestern Utah. *Astragalus canadensis* has one of the widest ranges of any North American *Astragalus*, embracing nearly the entire eastern half of the United States, ranging south to the coast of Texas. *A. lentiginosus* is a highly polymorphic species that lives in a great range of environments and altitudes, and includes several varieties that occur in the deserts of southern Arizona and California. It is possible that *C. alexandra* has a physiological intolerance to the higher temperatures of desert areas, although a population at 5600 ft. in the arid Henry Mountains of southern Utah indicates that *alexandra* should be sought in comparable environments in northern Arizona. Much of eastern Colorado, Wyoming, South Dakota, eastern Montana, and Alberta remain for further foodplant investigations.

Many members of the genus *Astragalus* are pioneer or "fugitive" spe-

cies, often colonizing barren ground unacceptable to other plant species, and then disappearing as more competitive species enter the area (Barneby, 1964). Several parallel cases of local abundance of a *C. alexandra* foodplant appeared to be the result of disturbance of the plant community by man and his animals. In the La Sal Mountains of Montrose Co., Colorado, large stands of *Lathyrus leucanthus* were found growing next to stumps of *Pinus ponderosa* Lawson cut within the previous two years. In Piute and Juab Counties, Utah, *Astragalus lentiginosus* was found most abundantly along road cuts and in areas where sage *Artemesia tridentata* had been cleared. *C. alexandra* females were observed ovipositing on *A. lentiginosus* growing in the rubble of an abandoned highway. *A. miser* at Black Canyon, Montrose Co., Colorado, was found in eroded gullies and in sage flats heavily grazed by cattle.

It seems reasonable to assume that *Colias alexandra* must be a highly mobile species in some parts of its range as it follows the expansion and contraction of populations of its *Astragalus* foodplant. Evidence from capture-recapture studies at Gothic, Colorado, where *alexandra* feeds on *L. leucanthus*, indicates that *alexandra* has a strong tendency to disperse as compared to the more sedentary *Colias meadii* Edwards (Ward B. Watt, pers. comm.). It was found from extensive travel over the range of *alexandra* that this species generally occurred in widely dispersed populations, with occasional local, large concentrations. A "large concentration" was one in which the density of adult *alexandra* was estimated at 20 or more individuals/100 m². A large concentration of *C. alexandra* was nearly always accompanied by a local abundance of a foodplant. A "local abundance" was one in which patches of the foodplant occurred at high densities within small areas that ranged from 100 m² to several km². *Astragalus canadensis* in Idaho was found in densities up to 100 stems/m² in some patches. In dry areas of Utah, clumps of *A. lentiginosus* were scattered, but individual plants were often 0.2 m or more wide.

Timber management practices in northern Idaho and Montana offer an explanation for the changes in population size of *Astragalus canadensis*, and for the spotty occurrence of *C. alexandra*. Closely related to the Siberian *A. uliginosus* L., *A. canadensis* var. *mortonii* is a conspicuous species, often reaching 0.8 m in height, with a head of greenish-white flowers which later form a cluster of small, erect ellipsoid pods. The outstanding characteristic of *canadensis* is its occurrence in large patches as a result of vegetative spread by rhizomes. Patches of the species are easily seen while driving at high speeds along the highway. *A. canadensis* grows most abundantly in lodgepole pine, *Pinus contorta* Dougl., forest that has just been logged and cleared. Dense stands of

TABLE 1. Oviposition Records for *Colias alexandra*.¹

Plant Species	Locality	Associated Vegetation, Geologic Formation
1. <i>Astragalus miser</i> Dougl. var. <i>oblongifolius</i> (Ryd.) Cron.	(A) COLORADO: Montrose Co., Hwy. 90 above E. Fk. of Dry Creek, Uncompahgre Plateau, S. 2, T. 47N., R. 96W., 8100' 29 June 1971 Ovip. 1100 MST on leaves at tip of stems. (CU) SLE (B) COLORADO: Montrose Co., Crystal Dam Road, 1 mi. S. of Black Canyon Natl. Mon. Boundary, NE ¼ of SE ¼ S. 8, T. 49N., R. 7W. 8530' 21 July 1971 Ovip. 1200 MST on leaves. (CU) SLE	scrub oak <i>Quercus gambelli</i> Nutt., sage <i>Artemesia tridentata</i> Nutt., on Dakota Sandstone: Cretaceous
2. <i>Astragalus bisulcatus</i> (Hook.) A. Gray var. <i>haydenianus</i> (Gray)	(A) COLORADO: San Miguel Co., Sand Rock Road, nr. Bell Canyon Reservoir, SW ¼ of SE ¼ S. 9, T. 42N., R. 18W. 8015' Uncompahgre Natl. Forest. 12 July 1971 Ovip. 1030 MST on leaves. (CU) SLE	<i>Q. gambelli</i> , <i>A. tridentata</i> , wild buckwheat <i>Eriogonum</i> sp., on Dakota Sandstone
3. <i>Astragalus lentiginosus</i> Dougl. in Hook. var. <i>diphyus</i> (Gray) Jones var. <i>araneosus</i> (Sheld.) Barneby var. <i>salinus</i> ² (Howell) Barneby	(A) UTAH: Wayne Co. Bull Creek Pass Road, N. Side Henry Mtns. NW ¼ of S. 20, T. 30S., R. 18W. 5600' 11 May 1966 Ovip. 1030 MST on leaves. SLE (A) UTAH: Piute Co., Hwy. 153, 1 mi. W. of Junction. 6000' 20 June 1972 Ovip. 1130 MST on leaves. (CU) #7219 SLE (B) UTAH: Juab Co., Hwy. 6-50, Jericho Turnoff. 5400' 25-26 June 1972 Ovip. 1200, 1330 MST (CU) #7220 SLE (A) IDAHO: Twin Falls Co., Magic Hot Springs Road, 4 mi. E. of Rogerson. 4500' 1 July 1972 SLE (B) IDAHO: Butte Co., 2 mi. NW of Atomic City, Hwy. 26. 4500' 6 July 1972 SLE (C) IDAHO: Cassia Co., Hwy. 77, 0.5 mi. N. of Junction with Elba-Malta Road. 5000' 3 July 1972 (CU) #7221 SLE	scattered Juniper, short grasses, on alluvial gravel derived from diorite porphyry sage (<i>Artemesia</i>)—covered flats, on sandy alluvium in disturbed soil sage-covered flats, scattered <i>Juniperus</i> sp., on sandy, disturbed soil and in openings among sage sage flats, sandy soil derived from basalt sage flats, sandy soil derived from basalt sage flats, road cuts in sandy alluvium

¹All records followed by (CU) were determined by Dr. W. A. Weber of the University of Colorado Herbarium. Records followed by field numbers indicate that the plant specimens have been deposited in the C.U. Herbarium collection. Distribution and determination of *Astragalus* varieties were greatly aided by the comprehensive work of Barneby (1964).
²This variety is inferred to be a foodplant by its association with *Colias alexandra* populations, and by the fact that *alexandra* oviposited on other members of the *A. lentiginosus* complex.

TABLE 1. (Continued)

Plant Species	Locality	Associated Vegetation, Geologic Formation
4. <i>Astragalus eremiticus</i> Sheld. Complex	(A) NEVADA: White Pine Co., Berry Cr., S-hell Creek Range, 7800', Humboldt Natl. Forest 28 June 1972 Ovip. 1530 PST (CU) #7223 SLE	sage flats and grassy hillsides, on gravel soil derived from limestone
5. <i>Astragalus canadensis</i> L. var. <i>montonii</i> (Nutt.) S. Watson	(A) IDAHO: Kootenai Co., Bunco Cr. Road Cutoff, 0.5 mi. S. of Farragut State Park on Lake Pend Oreille. 2100' 13 July 1972 Ovip. 1000 PST (CU) #7224 SLE (B) IDAHO: Boundary Co., Intersection Herman Lake Road with U.S. Hwy. 2, 3 mi. W. of Montana border. 2500' 16 July 1972 In assoc. with <i>C. alexandra</i> . (CU) #7225 SLE (C) MONTANA: Mineral Co., Cabin City Campground Rd. off Old U.S. 10, 3 mi. SE of De Borgia. 3300' 23 July 1972 Ovip. 1500 MST (CU) #7226 SLE	thinned stands of lodgepole pine <i>Pinus contorta</i> Dougl., roadsides and clearings in sandy glacial till recently logged stand of lodgepole pine in sandy soil, burnpile ashes in mixed lodgepole pine-Douglas fir <i>Pseudotsuga</i> sp. forest, along road cut, sparsely under trees in rocky soil
6. <i>Lathyrus leucanthus</i> Rydb.	(A) COLORADO: Montrose Co., 2 airline mi. N. of Buckeye Reservoir, La Sal Mtns. T. 48N., R. 20 W. 8000' 27 June 1971 Ovip. 1230 MST (CU) SLE (B) COLORADO: Mesa Co., SOB Creek, 8 mi. W. of Hwy. 65, Lands End Road, Grand Mesa. 10,000' 7 July 1971 Ovip. 1300 MST (CU) SLE (C) COLORADO: Gunnison Co., base of Crested Butte, 9000' 13 July 1967 J. F. Emmel & A. O. Shields (JFE #2, deposited Dudley Herbarium, Stanford U.)	recently cut stand of ponderosa pine <i>P. ponderosa</i> Lawson, clay soil on Dakota sandstone sage flats, <i>Lupinus</i> , <i>Wyethia</i> , <i>Penstemon</i> , <i>Castilleja</i> , rocky soil derived from basalt sage flats, rocky soil

canadensis were observed growing in the ashes of burn piles, and in still-visible tractor tracks. Young stands of *P. contorta* are thinned for optimum growth, and *A. canadensis* and many other species of herbs cover openings in the thinned forest. *A. canadensis* becomes much less frequent in mature or stagnant lodgepole pine stands, or in dense Douglas fir, *Pseudotsuga menziesii* (Mirb.) Franco-Western red cedar, *Thuja plicata* Bonn, forest. Direct comparisons for butterfly abundance were made between adjacent logged and unlogged stands. *C. alexandra* was found commonly only where *A. canadensis* was abundant, although large patches of *A. canadensis* were found where no *C. alexandra* were seen. It seems possible that present timber maintenance methods have replaced a natural fire cycle which opened up clearings for invasion of *A. canadensis*, an early seral stage plant.

The single factor of foodplant abundance as a cause of large *alexandra* populations is insufficient in itself. Increased nectar sources, and an open habitat for increased adult interaction may contribute to large populations. It was noted that *Lycaena mariposa* Reakirt, *Lycaeides argyrognomen* Bergstrasser, and *Colias interior* Scudder were often extremely common in northern Idaho forest openings where *C. alexandra* was abundant.

W. H. Edwards discovered that *C. alexandra* enters a 3rd instar diapause. This may be an adaptation in response to desiccation of the foodplant. In Juab and Piute Counties, Utah, at the end of June 1972, *Astragalus lentiginosus* var. *araneosus* was found in an advanced stage of desiccation, with most small plants completely withered. A few large plants, on which *C. alexandra* was ovipositing, held mature pods on some stems, and were still blooming on others. No new growth was observed, and leaves were hard and leathery. With high evaporation rates and scant rainfall in this part of Utah, the risk of drought is great during the summer months. Even in an area of comparatively high rainfall such as Gothic, Gunnison County, Colorado, C. L. Remington (pers. comm.) has noted that *Lathyrus leucanthus* withers toward the end of July.

There was little opportunity for field observations on choice of foodplants by *alexandra*. In most populations where ovipositions were observed, only one species of *Astragalus* or *Lathyrus* was found, although search for other species was made. In many areas two or more acceptable foodplants surely must occur within the range of one *alexandra* population. In the Schell Creek Range of White Pine Co., Nevada, Barneby (1964) records varieties of *Astragalus lentiginosus* and *A. miser* within the area where *alexandra* was found ovipositing on *A. eremiticus*. In Cassia County, Idaho, at 5000 ft. on 3 July 1972, *C. alexandra* was

found abundantly in a small field (75×75 m) of alfalfa, *Medicago sativa* L. Between 1000 and 1200 MST *alexandra* was estimated at a density of 150–200 individuals in the field at one time. Such large numbers of this species had not been encountered previously, and it occurred to me that *alexandra* might be using *Medicago* as a foodplant in this locality. Careful observation of nearly thirty females during the prime oviposition time of late morning revealed only nectar-seeking behavior, and no oviposition or courtship behavior. Scattered *Astragalus lentiginosus* var. *salinus* plants were found along the road cut, and among sage shrubs bordering extensive sage and juniper flats. This discovery led me to believe that the source of the *alexandra* population was a colony of the *Astragalus* growing in the sage flats, with *alexandra* adults moving into the alfalfa field to feed.

Volitinism. *Colias alexandra* is a univoltine species over most of its range. Emergence times vary for different populations, with western Colorado ones generally appearing several weeks before those in the Great Basin, Arizona, and in the northern Rockies. Lengths of emergence vary from 3 weeks in populations from dry areas in western Colorado to 2 months along the Front Range in eastern Colorado.

Mike Fisher discovered a bivoltine *alexandra* population on the high plains near Parker, Douglas Co., Colorado. Confining dates for the two broods are, first brood: 25 May–22 June; second brood: 25 July–19 August, with no stragglers between broods. *C. alexandra* oviposited on *Oxytropis lambertii* in this area, although *Astragalus* species may be used as well.

Interspecific Relationships with other *Colias*. Throughout its range *C. alexandra* is almost always sympatric with at least one other species of *Colias*, and in some areas up to four. *C. alexandra* and *C. philodice* are most often sympatric, although the peaks of their broods are not always synchronous. Ae (1959) states that in Colorado opportunities for interspecific mating are rare between widespread *Colias* species (*philodice* and *eurytheme*) and the “northern” species (*alexandra*, *scuderi* Reakirt, and *meadii*) due to seasonal isolation. In western Colorado, the peak of *alexandra*’s flight period occurs between the spring and summer broods of *C. philodice*. On Mesa Verde, Montezuma Co., on 26 May 1972, the *alexandra:philodice* ratio was 5:1, and on 16 July 1971 in the same locality, the same ratio was 1:8. In Cassia Co., Idaho, in an alfalfa field on 3 July 1972, the *alexandra:philodice* ratio was in the range of 100:1, with no *C. eurytheme* seen. In western Colorado *C. eurytheme* is quite rare when *C. alexandra* flies in late June, but becomes more common after *alexandra* disappears. Throughout the Great Basin *alexandra* flies with both *C. eurytheme* and *philodice*, and

in northern Idaho is sympatric with *C. interior* as well. Near Lake Pend Oreille, Kootenai Co., Idaho in thinned lodgepole pine forest on 14 July 1972, *Colias* collections were made along a 0.2 mile strip of logging road from 0900 to 1200 PST. In this limited area nearly 200 *C. alexandra* were seen and collected, as well as 10 *C. interior*, 6 *C. eurytheme*, and 2 *C. philodice* (all specimens seen of the last 3 species were collected). Several unsuccessful attempts by *alexandra* males to copulate with *interior* females were observed in this locality. Where *alexandra* and *interior* are sympatric, *alexandra* frequents open areas along roadways and meadows, while *interior* is found more often in the shade of pine woods. *C. interior* invades meadow habitats in localities where *interior* is more common than *alexandra*.

In Canyon Creek Canyon, Ochoco Mountains, Crook Co., Oregon, where *C. alexandra* and *C. occidentalis* Scudder are sympatric, A. O. Shields (in litt.) notes that the two species are easily separable on the wing, and that there are other behavioral differences. *C. occidentalis* "was more confined to openings and edges of woods than *alexandra*, though both taken commonly in open, broad meadows." In Canyon Creek Canyon on 10 July 1970, Shields observed oviposition by *C. occidentalis* on the leaf underside of *Lathyrus lanszwertii* Kell. (Shields #109, det. J. T. Howell, Calif. Acad. Sci.). Shields saw a species of lupine *Lupinus latifolius* J. G. Agardh. (Shields #86) in Canyon Creek Canyon, the same foodplant species used by *C. occidentalis* at Camp Ellendale, Glenn County, California.

Adult Nectar Sources. A study of nectar sources for several populations of *C. alexandra* indicates that the insect visits a variety of plant species. Throughout western Colorado and parts of Utah the greatest concentrations of *alexandra* were found on various species of thistle *Cirsium* (Compositae). One large population on the South Rim of the Black Canyon, Montrose Co., Colorado, was found almost exclusively on Canadian thistle, *Cirsium arvense* L. This plant population had been introduced during the previous five years after the construction of a new road. On 29 June 1971, on the Uncompahgre Plateau, Montrose Co., Colorado, *alexandra* was observed to ignore *Cirsium* sp. in favor of mules ears, *Wyethia arizonica* Gray (Compositae). In Cassia Co., Idaho, *alexandra* chose the blossoms of *Medicago sativa* and bindweed *Convolvulus arvensis* L. (Convolvulaceae) over those of a *Chrysothamnus* species (Compositae) which attracted *Satyrium fuliginosum* Edwards, *Speyeria zerene* Boisduval, *Cercyonis oetus* Boisduval, and *Hesperia harpalus* Edwards. In northern Idaho, *Cirsium* sp. was completely ignored, and *alexandra* was found most commonly on its foodplant, *Astragalus canadensis* var. *mortonii*.

Nectar sources are especially significant in concentrating *alexandra* populations in arid country. The widespread introduction of weeds, especially *Cirsium* sp., along roadcuts may have local effects on the density of *alexandra* populations. At Jericho Turnoff from Hwy. 6-50, 5400 ft., Juab Co., Utah on 25 June 1972, *C. alexandra* was collected on two small thistle patches (tentatively identified as *Cirsium vulgare* L.) along an abandoned highway. This locality was extremely arid, with extensive sage flats changing to sand dunes a few miles to the west. No moisture in the form of mud or streams was available. The only other nectar sources utilized in this area were a few scattered blossoms in *Astragalus lentiginosus* clumps, and the flowers of a small introduced mint growing on the roadcut. It appeared that the thistle patches were recent introductions, owing to the lack of previous years' stalks, and the absence of other thistles for many miles in all directions. Twenty-five *C. alexandra* were collected on thistle flowers from the two patches. A return to the area the next day netted only four specimens. Subsequent travel north, south, and west for several miles in each direction indicated that *alexandra* was either very scarce, or non-existent beyond 0.2 mi. from the thistle patches, although scattered *A. lentiginosus* clumps were seen along the Little Sahara Sand Dunes road to the west of Jericho. It appeared that we had collected nearly the entire emerged population from a large area, indicating that the thistle blossoms were a powerful attractant. This observation raises the question of whether adult nectar sources may be a limiting factor in the size of arid-land *alexandra* populations. In some areas, *alexandra* may be limited to the flowers of its foodplant, a situation shared by some desert-dwelling *Philotes*, and *Apodemia mormo* Felder & Felder, which feed on fall blooming *Eriogonum* species (Polygonaceae).

Behavior. *Colias alexandra* followed a consistent behavioral pattern over its range. In open country on warm days individuals of both sexes arrived at nectar sources about 1030. Males were least wary at this time, and most easily collected. After 1200, both sexes began to leave the nectar sources. Males congregated on mud, or flew continuously over meadows or along the edge of the forest. Oviposition by females occurred most often between 1000 and 1330. The fast flight and large size of *alexandra* made it easy to separate from other *Colias* species on the wing. Beak-marked individuals were very rare, and no attacks by avian predators were observed. Although hundreds of *alexandra* were observed on nectar sources, no copulating pairs were found. This suggests that courtship and mating may take place at a distance from nectar sources. *C. alexandra* moved away from open areas during the hottest hours of the afternoon, and then another brief nectar feeding

period occurred in some populations at 1600. On the Uncompahgre Plateau in San Miguel Co., Colorado, an individual was flushed from inside a sagebrush clump at 0800 MST where it had apparently spent the night.

SUMMARY

1. *Colias alexandra* oviposits on members of at least four genera of the Leguminosae: *Thermopsis*, *Astragalus*, *Oxytropis*, and *Lathyrus*. *Lupinus* is considered a very doubtful foodplant. Clover, *Trifolium repens*, is known to be a laboratory host. Field observations indicate that alfalfa, *Medicago sativa*, is an unlikely foodplant.

2. *C. alexandra* oviposited on two species of *Astragalus*, and one of *Oxytropis* which are known to be toxic to livestock. At least one species, *Astragalus bisulcatus*, is known to be a selenium accumulator.

3. *C. alexandra* foodplants are characteristically perennial, and show a scattered or patchy distribution. Several are dependent on the availability of disturbed plant communities and early seral stages in forests for their optimum growth. Two species, *Thermopsis divaricarpa* and *Astragalus canadensis*, form dense patches due to spread by rhizomes.

4. *C. alexandra* occurs most frequently in widely dispersed populations. Occasional large, local concentrations are found. It is suggested that these large, local *alexandra* populations are primarily dependent on the local abundance of a foodplant. Other factors such as an open habitat and increased nectar sources may contribute to the support of large *alexandra* populations.

5. Although univoltine over most of its range, a bivoltine *alexandra* population is known from the High Plains-Front Range contact area in Douglas Co., Colorado.

6. *C. alexandra* is nearly always sympatric with one or more species of *Colias*. Limited data suggest that there are temporal and behavioral differences between *alexandra* and other species of *Colias*.

7. Available nectar sources, particularly introduced weeds, may strongly influence density and size of *alexandra* populations occurring in very arid areas.

ACKNOWLEDGMENTS

The author is grateful to Arthur C. Allyn and Lee D. Miller of the Allyn Museum of Entomology, Sarasota, Florida, and to John M. Burns of the Museum of Comparative Zoology, Harvard University, whose support made travel and research possible during the summers of 1971 and 1972. F. M. Brown and A. B. Klots generously read and commented

on a previous draft of this paper. The ready willingness of W. A. Weber of the Colorado University Herbarium to make plant determinations is greatly appreciated. Conversations with J. M. Burns, C. L. Remington, and W. B. Watt provided valuable insights. R. Chehey, J. F. Emmel, M. S. Fisher, K. Johnson, J. Scott, and A. O. Shields freely gave helpful field observations on *Colias*. Special thanks go to my wife Lydia Thompson, whose assistance in the field was invaluable.

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A NEW SPECIES OF *COPTODISCA* (HELIOZELIDAE)
FROM MISSISSIPPI ON FARKLEBERRY
(*VACCINIUM ARBOREUM*)

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Coptodisca is a genus of very small moths. The forewing has silver and black markings on a white and yellow ground. The larva forms a mine in the leaf of its host by eating out the tissue between the upper and lower epidermis. When mature, the larva cuts a disc of tissue out of the leaf and uses it to form a cocoon. All known species of *Coptodisca* feed on woody plants, and most are restricted to a single plant genus. Nineteen species of *Coptodisca* have been described.

***Coptodisca matheri* Lafontaine, new species**

Figs. 1, 3, 4

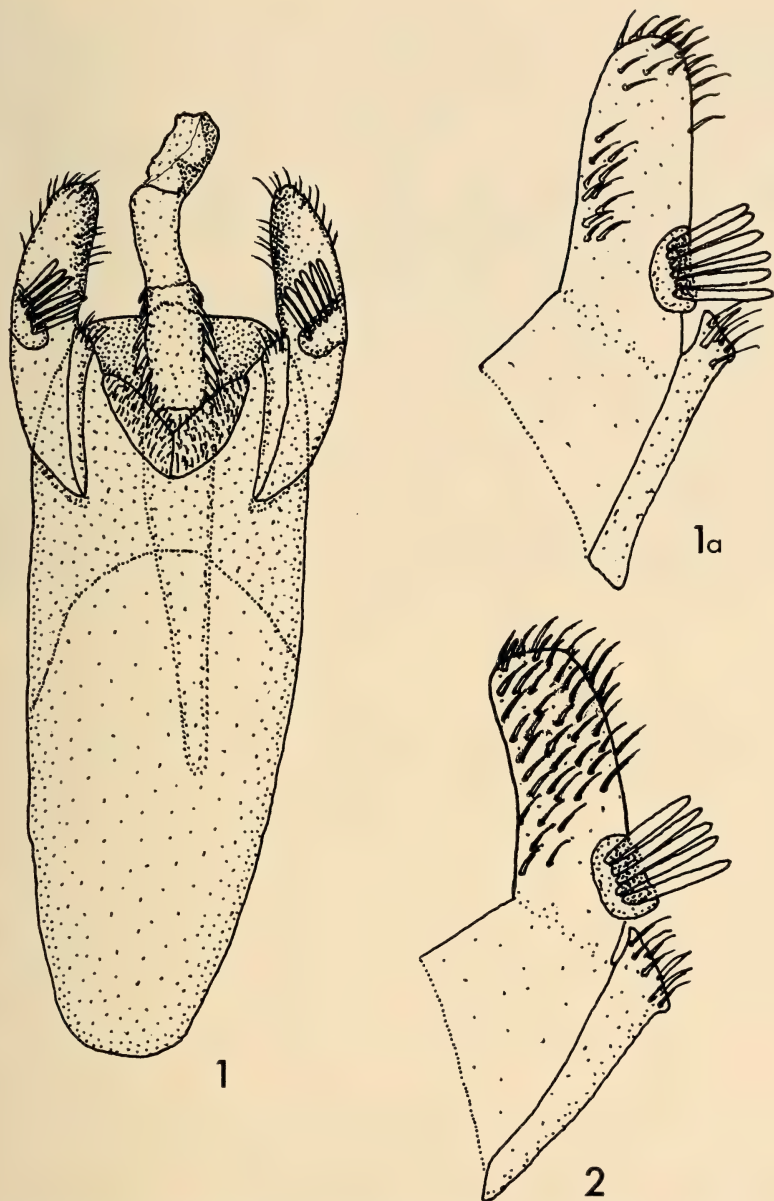
Antenna fuscous, vertex of head golden, face and labial palps white. **Thorax** and **abdomen** silver-grey above, white below. **Forewing** with silvery white basal half, and light yellow apical half. A (costal) spot two thirds of distance along costa and a spot opposite it on inner margin, each extending one third of the way across wing. Costal spot white, margined with dark grey. Spot on inner margin light grey, margined with dark grey. A grey patch at tornus which extends from distal edge of spot on inner margin to dorsum and termen. Apical patch wedge-shaped with a circular black base followed by a fan-shaped row of scales with light brown bases and black tips. Apical patch preceded and margined on both sides by white scales, separated from dark patch at tornus by yellow ground basally and some white scales distally. Yellow ground blending into dark patch at tornus between apex of spot on inner margin and apical patch. A small black wedge distal to costal spot, parallel to outer margin of spot. Cilia whitish grey, with black pencil of scales extending outward from apical patch. **Hindwing** and cilia uniformly whitish grey. **Expanse** $4.1 \pm .3^*$ mm. (6 specimens).

Male genitalia (Fig. 1): Genitalia excluding valves, $2\frac{1}{2}$ to 3 times as long as wide. Comb on valve with 6 teeth. Saccular setae on inner surface of valve in two small patches, one near dorsal edge and one near apex.

Female genitalia (Fig. 3): Similar to those of other species of *Coptodisca* except for tip of ovipositor. Central point of five pointed ovipositor is smallest. In other species of *Coptodisca* feeding on plants in Ericaceae central point enlarged and bulb-shaped, much larger than the other four points.

Type material: **Holotype** male, Jackson, Mississippi, emerged 7 September 1965 (Bryant Mather). Reared from *Vaccinium arboreum* Marsh. Type No. 13032 in Canadian National Collection. **Allotype** female, Jackson, Mississippi, emerged 25 January 1965 (Mather). **Paratypes**, one male, Jackson, Mississippi, emerged 25 January 1965 (Mather); two males, Clinton, Mississippi, emerged 22 December 1969 (Mather). Allotype and paratypes reared from same host as holotype. All specimens reared in laboratory at Ottawa.

* standard deviation



Figs. 1, 1a, 2. Male genitalia of *Coptodisca* spp.: 1, *C. matheri* n.sp.; 1a, right valve of *C. matheri*; 2, right valve of *C. negligens* Braun.

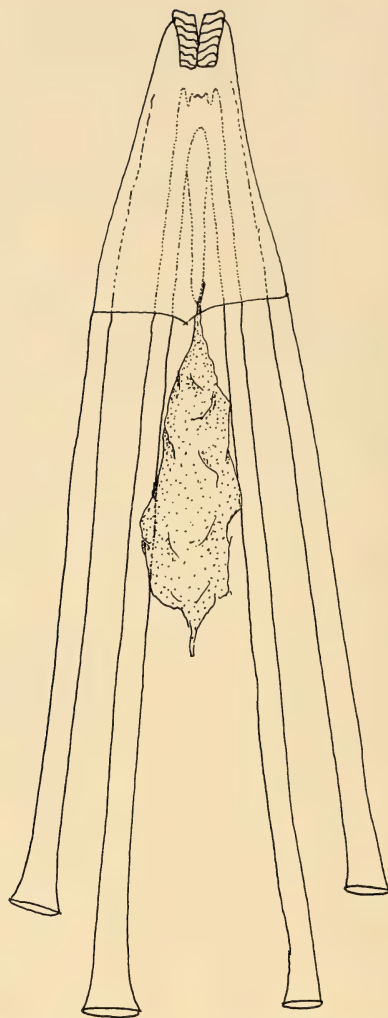


Fig. 3. Female genitalia of *Coptodisca matheri* n.sp.

Distribution: Known only from central Mississippi but undoubtedly more widely distributed.

Foodplant. Farkleberry (*Vaccinium arboreum* Marsh.)

Mine. The mine usually follows the leaf margin. It begins at the base of the leaf near the top of the petiole as a serpentine mine, and widens into an elongate blotch slightly wider than the oval disc cocoon cut from the mine by the larva. The initial portion of the mine is completely filled with frass. Mr. Mather's observations of the mining habits of this species on Farkleberry indicate that there are at least two generations each year.



Fig. 4. *Coptodisca matheri* n.sp., upperside of holotype.

This is the most lightly coloured species of those which feed on plants of the Heath family. *Coptodisca matheri* can be separated from *C. arbutiella* Busck (1904: 769) and *C. kalmiella* Dietz (1921: 44) by the lack of the dark lead ground colour on the basal half of the forewing present in *arbutiella* and *kalmiella*. The comb on the valve of the male genitalia of *matheri* has 6 teeth, not 7 to 9 as in *arbutiella* and *kalmiella*.

Coptodisca matheri is most easily separated from *C. magnella* Braun (1920: 79) by its lack of a sharp contrast on the forewing between the yellow ground colour and the dark patch at tornus. In *matheri* the pale yellow ground colour gradually blends into the dark colour of the patch at tornus.

Coptodisca matheri differs from Dr. Braun's (1916: 138) description of *C. negligens*, and from specimens which match her description reared from *Vaccinium angustifolium* Ait., by the lighter yellow colour on the forewing, and by the golden rather than grey colour of the scales on the vertex of the head. The valve of the male genitalia of *matheri* (Fig. 1a) is much less extensively setose than that of *negligens* (Fig. 2). The comb on the valve of *matheri* has 6 teeth not 5 as in *negligens*.

The following is a key to the known species of *Coptodisca* which feed on species of plants in the Heath family (Ericaceae).

- 1—Yellow ground colour continuous between costal spot and spot on inner margin 2
- Ground colour interrupted between these spots by a mottling of dark scales 4
- 2—Head silvery-lead, concolorous with thorax and base of forewing; *Arbutus*-feeder *C. arbutiella*
- Head golden 3
- 3—Sharp contrasting line where yellow ground meets dark posterior patch; *Gaylussacia*-feeder *C. magnella*
- Yellow ground colour blending gradually into dark patch at tornus; *Vaccinium*-feeder *C. matheri*
- 4—Comb on valve of male genitalia with 7–9 teeth; *Kalmia*-feeder *C. kalmiella*
- Comb on valve of male genitalia with 5 teeth; *Vaccinium*-feeder *C. negligens*

ACKNOWLEDGMENT

I wish to thank Dr. T. N. Freeman formerly of the Entomology Research Institute, Canada Department of Agriculture, for reviewing this manuscript and making helpful suggestions.

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POTENTIAL FECUNDITY OF *RHYACIONIA NEOMEXICANA*
(DYAR) (OLETHREUTIDAE) RELATED TO PUPAL SIZEDANIEL T. JENNINGS¹

Adult size and weight have been related to female fecundity for a number of Lepidoptera. Weight of emerging moths is positively correlated with numbers of eggs deposited for *Ephestia elutella* Hübner (Waloff, Norris & Broadhead, 1948). Because weight may vary greatly with age and with environmental conditions such as temperature and humidity, more intrinsic and stable indicators of moth size are desirable. Wing length, a more constant indicator of moth size than body weight, has been used as an indicator of fecundity for *Crambus harpipterus* Dyar and *Agriphila plumbifimbriella* Dyar (Crawford, 1971), and for *Oncopera intricata* Walker (Martyn, 1965).

Pupal size was used as an indicator of fecundity by Williams (1963) for *Proceras sacchariphagus* Bojer and by Miller (1957) for *Choristoneura fumiferana* (Clemens). Johnson (1968) used the same approach as Miller to establish the relationship between pupal size and fecundity of *C. pinus* Freeman. In these instances, adult moths were reared from measured pupae and allowed to deposit their eggs. The amount of oviposition in turn was related to pupal size. This approach has the advantage that once the relationship between oviposition and pupal size has been determined, then fecundity can be estimated from empty pupal cases after moth emergence. Disadvantages include problems associated with rearing pupae to adulthood, and ovipositional performance of emerging females.

A count of the developing oöcytes in pupae approaching eclosion offers a possible index of potential fecundity. The present study was designed to determine if potential fecundity could be estimated from overwintering pupae of *Rhyacionia neomexicana* (Dyar). This paper relates oöcyte complements of *R. neomexicana* pupae to two measures of pupal size.

METHODS

R. neomexicana overwinters as pupae enclosed within cocoons. Cocoons are attached to the root collars of host trees, *Pinus ponderosa* Laws., an average of 2.63 ± 0.90 cm ($n = 67$) beneath the soil surface.

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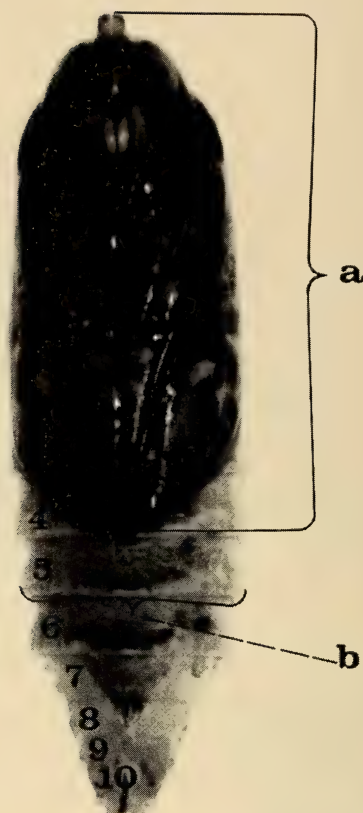


Fig. 1. Female *Rhyacionia neomexicana* pupa showing two measures of pupal size: (a) linear distance from anterior edge of frontal horn to apex of right wing pad, and (b) width of 5th abdominal segment.

A sample of overwintering pupae was dug 26 March 1970 about 10 days before initial male emergence and 20 days before initial female emergence. Cocoons were dug from the root collars of a natural stand of young pines on the Dudley Burn, Chevelon Ranger District, Coconino County, Sitgreaves National Forest, Arizona. They were placed in an ice cream carton with moist soil, transported to the laboratory (Albuquerque) in an ice chest, and stored in a refrigerator (ca. 5°C) until dissected.

In the laboratory, the cocoons were opened and pupae sexed by location

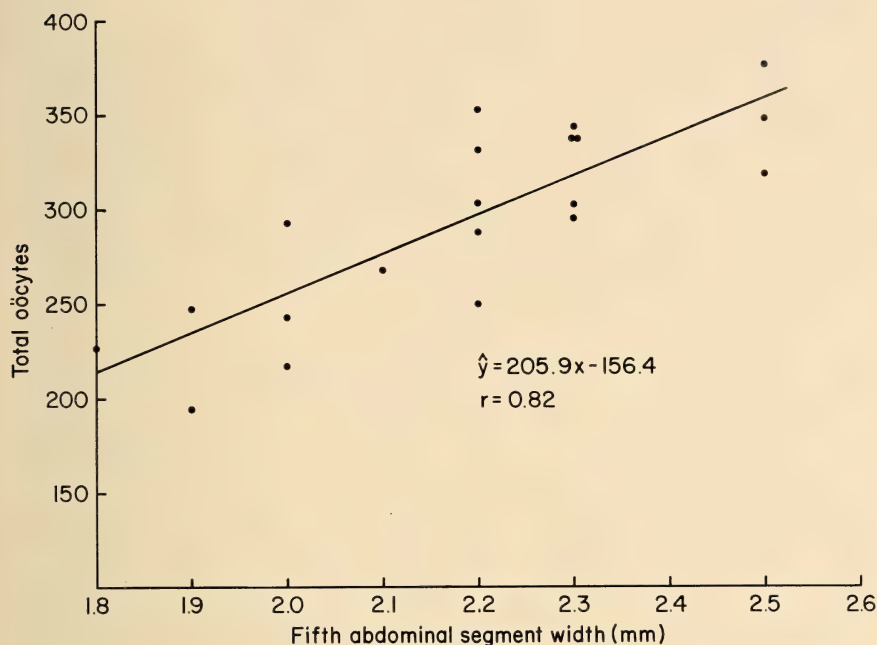


Fig. 2. Total oöcytes of *Rhyacionia neomexicana* pupae as a function of abdominal segment width.

and configuration of the genital pore. Live female pupae were measured to the nearest 0.1 mm using a dissecting microscope equipped with an ocular micrometer. Two measurements were made on each pupa: (1) the linear distance from the anterior edge of the frontal horn to the apex of the right wing pad (Fig. 1a), and (2) the maximum width of the 5th abdominal segment (Fig. 1b). The 5th segment is completely free of the wing pads, and remains intact after adult emergence.

Measured pupae were heat killed with a flamed dissecting needle and partially embedded in paraffin to facilitate dissection. Specimens were flooded with physiological saline, and the 8 chains of developing ova (ovarioles) removed. To minimize possible differences in oöcyte complements due to age or time of development, all pupae ($n = 20$) were killed and dissected within a 3-day period (30 March–1 April). Ovarioles from the 1st 10 pupae dissected were stained with Grenacher's Borax Carmine to differentiate ripe from unripe oöcytes (Crawford, 1971; Williams, 1963). For staining, ovarioles were submerged in the staining solution for 5 minutes, then de-stained by washing in 70% ethanol for 20–30 seconds. Ovarioles from the 1st 10 pupae were stained

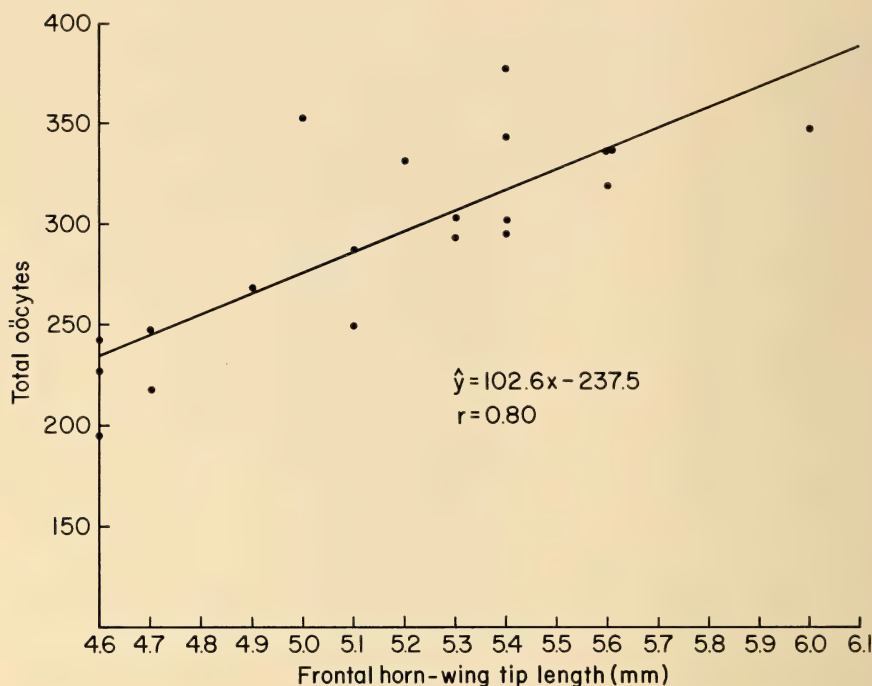


Fig. 3. Total oöcytes of *Rhyacionia neomexicana* pupae as a function of frontal horn-wing tip length.

and their oöcytes counted on the day of dissection, while ovarioles from the 2nd group of 10 pupae were stored in 70% ethanol and counted (unstained) at a later date. Only discrete, differentiated oöcytes were counted. Undifferentiated, developing oögonia in the germarium were not included.

Regression analyses were run to determine the relationship between oöcyte complement and 5th abdominal segment width and frontal horn-wing tip distance. The resulting equations were tested for the variation in Y explained by the fitted line at $F_{.01}$ with $\frac{1}{8}$ df.

RESULTS

All ovarioles ($n = 80$) in the 1st series of 10 pupae contained developing oöcytes that retained the stain, indicating the chorions impervious to the stain had not yet developed. Mean width of the 5th abdominal segment in dissected pupae was 2.18 ± 0.20 mm, and mean frontal horn-wing tip distance was 5.17 ± 0.40 mm. Total oöcytes (5,869) had a calculated mean of 293.45 ± 50.99 per pupa (range 194-377).

Both regression equations (Figs. 2 and 3) were highly significant, $P < 0.005$. Thus, a reasonable estimate of oöcyte complement for overwintering *R. neomexicana* pupae can be obtained from measures of pupal size. The equations indicate an increase of about 20–21 eggs per mm of abdominal width or frontal horn-wing tip length.

The abdominal width measure may be more useful than the frontal horn-wing tip measure for estimates of potential fecundity. The 5th abdominal segment remains intact after adult emergence while the frontal horn-wing tip unit is ruptured and displaced during eclosion.

DISCUSSION

Large overwintering *R. neomexicana* pupae as a rule have more oöcytes in their ovarioles than do small pupae. Regression equations demonstrate the linear relationships between pupal size and numbers of oöcytes found in the ovarioles. However, oöcytes in the pupal stage must be considered only as potential fecundity because additional oöcytes may be differentiated after adult emergence, and some oöcytes may be reabsorbed. Waloff et al. (1948) found that most of the eggs produced by *Ephestis elutella* Hübner were present at the time of adult emergence, but that virgin females reabsorbed 40% and fertilized females reabsorbed 17% of their egg rudiments. An 11% reabsorption of unripe eggs in the ovaries has been reported for *Proceras sacchariphagus* Bojer (Williams, 1963).

Other factors which may influence egg production are: availability of water and nutrients to emerging adults (Waloff et al., 1948; Williams, 1963); density and nutrition of larval populations (Martyn, 1965; Miller, 1957); mating condition of females, i.e., virgin vs. fertilized (Williams, 1963); environmental effects on oviposition, survival, and longevity of females (Waloff et al., 1948); environmental effects on larval stages (Cook, 1961; Tantawy & Vetukhiv, 1960); and changes in the genetical constitution (Willington, 1964). These factors should be considered and explored before assigning a mean fecundity to a population.

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NOTES ON THREE SPECIES OF *HEMILEUCA*
(SATURNIIDAE) FROM EASTERN OREGON
AND CALIFORNIA

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The information in this paper has been extracted from notes recorded by the author between 1962 and 1964. As basic information on the larvae of *H. n. nuttalli* and *H. h. hera* apparently still remains to be published (Ferguson, 1971, p. 137-147), it seems worthwhile to publish these notes without further delay. The larval descriptions that follow remain valid, despite the passage of time, although it is quite conceivable that one or more of the localities mentioned has since been altered (perhaps even obliterated) by those activities of *Homo sapiens* popularly termed "development" and "progress."

Hemileuca (Pseudohazis) nuttalli nuttalli (Strecker)

In late April 1962, more than 100 completely-black and unmarked *Hemileuca* larvae (of the subgenus *Pseudohazis*), in various instars from quite small (second or third instar) to nearly fullgrown, were given to me by Ken Goeden, who collected them on 25 April 1962, near the highway in low hills between 11 to 13 mi. west of Vale, Malheur Co., Oregon (elevation about 2800 ft.). He found them resting and feeding on bitterbrush, *Purshia tridentata* (Pursh) DC. (Rosaceae), which was

growing there in an association with the abundant and widespread Great Basin sagebrush, *Artemisia tridentata* Nutt. (Asteraceae).

The living *final instar larvae* of this eastern Oregon population of *nuttalli* were briefly described (and readily recognized) as follows: Skin uniformly dull black, with NO maculation; a slight shading toward brown on the venter, especially in thoracic region. Body covered with a floccose pubescence of fine, soft, grayish-white hairs. No variation in body (or spine) coloration evident. Spines and spine clusters all jet black. The unbranched, short, sharp, clustered dorsal spines have a mild but definite urticating ability, if pushed firmly against tender skin. Head and thoracic legs blackish to brownish-black; faintly shiny. Head pubescent. Several of these larvae (code-numbered *St.7*), including the corresponding notes, are preserved in my former North American larval collection (most of which now belongs to the Natural History Museum of Los Angeles County, California).

As an interesting aside, concerning foodplant tolerances, I should mention that a number of the larvae collected by Goeden (1962) were also sent to Christopher Henne, at Pearblossom, Los Angeles Co., California. It was necessary for him to locate a substitute plant species, and as a natural first guess he offered them (the viscid) antelope brush, *Purshia glandulosa* Curran, which grows south and southeast of Pearblossom (near Valyermo), but this plant was absolutely refused by the larvae! Next, *Cercocarpus betuloides* Nutt. ex T. & G. (also Rosaceae) was offered; surprisingly, they readily accepted this substitute of another genus in preference to the other *Purshia*. Several of Henne's larvae ultimately pupated and later produced perfect adults. I attempted to feed some of my captive larvae on *Artemisia*, but this was completely refused. The rest of my series died in the larval stage, due to lack of proper treatment in captivity. (See notes at end.)

The adult moths (reared by Henne) emerged in the summers of 1962 and 1964 (3 ♂♂ between 12-28 Aug. 1962; one ♀ on 13 Aug. 1964). Showing only minor variation in colors and markings, they were briefly described as follows: Forewing upperside groundcolor dull but chalky whitish, sharply-marked with black; sometimes with a suffusion of yellow-orange at outer margin, just inside the narrow black border. Hindwing upperside rich yellow-orange, sharply marked with black. Undersides of both wings uniformly dull yellow-orange, sharply-marked with black. Thorax and abdomen yellow-orange, in some cases slightly marked with black.

J. S. Buckett mentioned that he observed a diurnal flight of moths, fitting the above description, at around 1400 hrs. on 4 September 1963, in an area about 2 mi. W of Irrigon, Morrow Co., Oregon (elevation

about 400 ft.). Many of the freshly-emerged adults were resting on *Purshia* bushes, and "thousands" were seen on the wing. At the time of this observation the temperature was about 90° F.; there had been a substantial rain in the locality some days before the emergence. It was noted that the moths were restricted to areas where *Purshia* was growing. Two of the adults (♂ and ♀) collected by Buckett are in my present collection; presumably others are in the Buckett collection.

Hemileuca (Pseudohazis) eglanterina eglanterina (Boisduval)

On 14 June 1964, David L. Mays gave me 40 gregarious first instar larvae of an unidentified *Hemileuca* sp. (subgenus *Pseudohazis*), which he had collected a few days earlier on *Purshia tridentata* (det. Mays), about 3 mi. N of Markleeville, Alpine Co., California, southeast of Lake Tahoe (at about 7500 ft. elevation). I transported these larvae south, to White Cliff Ranch, near Valyermo, Los Angeles Co., California, hoping to continue the rearing; there they readily accepted mature and semi-mature leaves of the local *Cercocarpus betuloides* as a substitute food-plant, and grew rapidly from second and third instars to maturity *on that plant*; this was followed by healthy pupae. (Incidentally, they also practically refused to accept the local *Purshia glandulosa*, which was offered as the first potential substitute, although a little feeding did take place on it.)

The *final instar larvae* (20 July 1964), were briefly described as follows: Dorsum contrasting abruptly with venter. Skin dull black down to the prominent, undulate cream-white subspiracular line; below this line, including prolegs completely, skin grayish-flesh-pink to pinkish-brown. Subspiracular line white, with two narrower whitish supra-spiracular lines; the uppermost lines much-suffused by large blotches of pale pinkish-purple centered between them, and blocking them out at intervals. Spines in the two dorsal rows of short, sharp (stinging) spine-clusters black, toward center of each cluster, but *outermost* spines of these clusters pale straw-yellow, minutely black-tipped. (In earlier instars, these identical spine-clusters contained predominantly light golden-brown spines.) The longer subdorsal and lateral spines primarily black. Body covered with fine, soft, grayish-white hairs. Head shiny blackish-brown with faint reddish-purple tinge; pubescent. Thoracic legs black and glossy. This description was drawn from notes on several of the *living* Markleeville larvae; some of these were preserved under my code-number *St.16* (now in the Natural History Museum of Los Angeles County). It would not be surprising if larvae of *this species*, from various widely-separated populations, were found to show considerable variation in color and/or maculation.

These larvae were gregarious when small, clustering together both while resting and while feeding. They always followed each other in a perfect single file procession when moving to new locations. This gregarious behavior was *gradually lost* as they grew older, becoming essentially non-existent in last instar.

All pupae obtained were given to Christopher Henne; adults (1 ♂; 1 ♀) emerged in July 1965. Pupation took place in the typical "*Hemileuca*-type" of surface-debris cocoon or cell, *under* some sheltering object (such as a rock or board), but always on or only *just* below the soil surface; soil grains, small pebbles, and any other nearby particles of litter, were densely-incorporated into the relatively soft and flexible, silk-tied cell walls.

Hemileuca (Pseudohazis) hera hera (Harris)

For comparison with the larvae just described, a brief description of the final instar larva of *Hemileuca hera* (based on a few living individuals from one population) seems worthy of inclusion here. I collected these larvae on 26 July 1964, when on a brief trip with Edmund C. Jaeger, in the Inyo Mountains, Inyo Co., California, at approximately 10,000 ft. elevation, about 3 mi. SW of Waucoba Peak. They were feeding on *Artemisia tridentata* (Great Basin sagebrush), which was growing patchily in the more open areas of a bristlecone pine forest (*Pinus aristata*). On this date both penultimate and last instar larvae were present on their foodplant; unhatched egg-masses were also noticed, and a few females were observed in the act of ovipositing. Many adult males were on the wing; a few pairs were seen in copulation, resting on the sagebrush.

When transported to White Cliff Ranch, near Valyermo in the San Gabriel Mts., (elevation close to 5000 ft.), these larvae hardly nibbled at the local sagebrush (probably a distinct subspecies or variety of *A. tridentata*), and soon began to decline as starvation ensued. None of them filled out or reached a prepupation condition. They were also offered *Cercocarpus betuloides* as a last resort, but this plant was totally refused. Daily sunlight and fresh air were provided, so it was not for lack of these that the larvae died. It is possible that the rapid drop in elevation had as much of a bad effect on them as did my attempt to force them onto a distinctly different form of the foodplant species; both of these factors were probably responsible for their decline.

The *final instar larvae* (McFarland code-number *St.17* in the Los Angeles County Museum), were briefly described as follows: Skin of dorsum and sides dull black; venter, including bases of prolegs, pale grayish-brown. Dorsum and sides marked with several full-length lines

of cream-white: a closely-parallel pair of narrow, broken middorsal lines; a broader and nearly solid subdorsal line; a slightly narrower, undulate supraspiracular line; a similar undulate subspiracular line. Body covered with a fine, soft, grayish-white pubescence. Spines in the two dorsal rows of short, sharp (stinging) spine-clusters mostly pale straw-yellow basally and widely-tipped with black. Longer lateral spines primarily glossy black with some straw-colored basal branches. Thoracic legs and lateral shields of prolegs glossy black. Head deep glossy black; pubescent.

Eggs collected on *Artemisia tridentata* at the Inyo Co. locality, were briefly described as follows: deposited on the foodplant twigs, in compact, and securely-glued encircling-bands, with *no* covering of scales, "fluff," or dried froth, etc. Among those egg "masses" observed, numbers ranged between 20 and 80 eggs per mass. The chorion was very tough, smooth, and glossy. Color at this stage (not long after oviposition) was a uniform pale *whitish-gray-green*, without bands, spots, or other maculation. The egg color was rather close to that of the (Inyo Mts.) sagebrush leaves, but had less green in it. The eggs probably overwinter, hatching perhaps in late May or sometimes in June at this elevation.

H. hera, and its abundant (often dominant) widespread foodplant, *Artemisia tridentata* Nutt., are also present in eastern Oregon, but the *Purshia*-feeding *H. nuttalli nuttalli* appears to be of more localized distribution there, probably only occurring in certain areas where its (less-abundant) foodplant grows.

Some reared adults from the above-described *Hemileuca* larvae, with the exception of *hera*, are in the Henne collection.

Notes on Rearing *Hemileuca* Larvae Successfully in Captivity

Most *Hemileuca* larvae can prove to be delicate in captivity, and will usually decline (slowly) and die IF deprived of fresh air and sunlight. Daily SUNLIGHT appears to be particularly important to stimulate vigorous feeding and normal, healthy growth in these larvae. (Electric lighting can be used but is only a poor substitute; never use "Cool White" fluorescent.) If housed in *thoroughly-ventilated* cages, with sprigs of *foodplant kept fresh* in water, and if given *about one hour of sunlight daily* (or at least as often as it is available), they will thrive and are definitely NOT difficult to rear. A light *sprinkling of water* over the foodplant, at least every second or third day (in the early morning), is highly desirable. With reference to the sun requirement, it is imperative that some *shade* also be available at all times during the sunning-period, so that the larvae can move quickly and easily from a sunny location into the shade as individually required. To provide such condi-

tions, a cage that is all plywood on top *and* on two opposite or adjacent sides, with screen only on the other (two) sides, is ideal. This makes it possible to safely leave the cage in a completely sunny location all morning, without any need of further attention, while insuring that there will constantly be areas of *both* sun and shade within; ample ventilation is also provided. If it is semi-cloudy, it may sometimes be necessary to leave the cage in a potentially sunny location all morning in order to accumulate enough actual "sun-time" to benefit the larvae; yet, on a hot and clear morning, they might be urgently needing to seek shade within less than an hour after the sunning began. The constant presence of some zones of shade in the cage will also guarantee less drastic wilting of (at least a portion of) the foodplant sprigs—another important factor in many cases.

Incidentally, the above suggestions will also be found helpful in connection with a number of other "difficult" bombycoid larvae in captivity, such as the rare Californian saturniid, *Saturnia albofasciata* (Johnson), and certain Australian anthelids (some *Pterolocera* and *Anthela* spp.); also applicable to a few arctiids (some *Apantesis* spp.), many agaristids, and to a wide scattering of unrelated genera in various other macro families *where strictly diurnal-feeding larvae are involved*.

ACKNOWLEDGMENTS

I would like to thank D. S. Fletcher (British Museum Nat. Hist.) for recently reviewing this manuscript, and for thoughtfully providing needed photocopies of relevant pages from the reference cited below. I am deeply indebted to Ken Goeden (Oregon) for giving me the *nutalli* larvae, to David L. Bauer (Calif.) for a most helpful discussion (letter: 26 January 1966) further verifying the species described in this paper, and to Christopher Henne (Calif.) for completing the rearing of the Markleeville larvae when I was preparing to leave for Australia in 1964.

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LIFE HISTORY NOTES ON SOME *HEMILEUCA* SPECIES
(SATURNIIDAE)

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Ferguson's treatment of the Saturniidae (1971) provided much valuable information for those particularly interested in *Hemileuca*. He presented certain questions for further study, as he had not enough material on hand to make definite statements. I want to record here some of my experiences in rearing members of this group and provide information that might assist in clarifying some of the shadowy areas. I also would like to add some of my rearing methods and misfortunes in hopes that they will help others to avoid my errors and thus be successful in their initial attempts at rearing the members of this beautiful group.

Hemileuca maia (Drury)

Ferguson mentions the great confusion that exists between the oak eating *H. maia* and the willow eating *H. nevadensis* (Stretch), including the lack of information available to verify the acceptability of foodplants other than *Quercus* for *maia*. In May and June 1972 I reared *maia* from ova received from Irwin Leeuw of Cary, Illinois. These ova were collected on scrub oak at Colonie, Albany Co., New York, on 15 April 1972. This is well within the range of true *maia* and well away from the influence of *nevadensis*. I successfully reared these larvae to maturity on *Salix* (willow) from the Mojave riverbed near Victorville, San Bernardino Co., Calif. I tentatively identified the willow as sandbar willow, (*Salix hindsiana* Benth). The larva readily accepted this as an alternate foodplant after feeding on a California scrub oak (*Quercus chrysolepis* Liebm.) for two instars. I had an 80% successful pupation rate and emergence began in September 1972. So apparently *maia* does accept *Salix*, at least in captivity. I leave it to the Midwest collectors to solve the *maia-nevadensis* confusion in that area.

Hemileuca electra (W. G. Wright)

Ferguson mentions that he saw too few specimens of *H. electra clio* (Barnes and McDunnough) to give a definite statement on the validity of its status as a subspecies. Southern California collectors who have had experience with this species feel that *clio* extends its range into California on the Mojave Desert plateau to the desert foothills of the

San Bernardino, San Gabriel, and Sierra Nevada mountains. Larvae and ova masses are found on *Eriogonum fasciculatum* var. *poliofolium* (Benth) within this range and the adults match closely to *clio*. *H. electra electra* on the other hand occurs on the coastal slopes of these ranges, to the ocean, feeding on nominate *E. fasciculatum* (Benth). In the 1972 season, I reared the larvae of these two subspecies side by side to find out if there were larval differences that might strengthen the validity of these two forms as subspecies.

I took 20 first instar larvae of *e. clio* on 27 February 1972 at Rock Corral, 20 miles east of Lucerne Valley, San Bernardino Co., California. I also took 30, third to fifth instar, larvae of *e. electra* on 25 March 1972 from one mile west of Lake Mathews Dam, Riverside Co., California. The following differences were observed in the physical appearances of the fifth instar larvae of each group.

a. The spines on the lateral rows of *e. electra* were as described by Ferguson, "black with yellowish tips." This trait was consistent on all the Lake Mathews larvae. All *e. clio* larvae from Rock Corral had the lateral rows of spines colored solid black, without any yellow tips.

b. When compared, the *e. clio* larvae had much less white mottling or spotting on the body than did the *e. electra*, a characteristic that gave the *e. clio* larvae a much darker over-all appearance.

c. The whitish line that flows lengthwise along the body of the larvae just above the spiracles is much more pronounced or "striking" in *e. clio* than in *e. electra*, and much straighter.

These larvae all pupated in late April and early May 1972 and began emerging in July 1972. I have taken *H. e. clio* larvae or ova from the Rock Corral spot, from the foothills south of Apple Valley, San Bernardino Co., and from one mile north of Red Rock Canyon, off Hwy 14, Kern Co., all in California.

After two years of unsuccessful attempts at rearing *e. clio* on its native foodplant, a very dry form of *E. fasciculatum*, in 1972 I transferred them to the nominate *E. fasciculatum* that *e. electra* feeds on. It is much longer-leaved and lusher, and I was successful in bringing the majority of the larvae through on this plant.

Hemileuca burnsi (J. H. Watson)

I have found larvae of this species commonly on *Tetradymia axillaris* (A. Nels) cotton thorn, and *Prunus fasciculata* (Gray) desert almond, in the foothills south of the Victorville-Apple Valley area of San Bernardino Co., California. These larvae are best collected in late January and early February when the foodplants are just beginning their growth and the black larval masses are easily spotted. Some

collectors are successful in finding the oval rings in the winter, but I am not one of them. Where I have searched long and hard for ova, I have found many larval masses in the spring. I have had pupae from *H. burnsi* continue to emerge for two years after pupation. These larvae and those of the other *Hemileuca* that I have had experience with are very susceptible to parasites, and therefore are best taken in the earlier instars.

I add some general comments on my experiences with the rearing of *Hemileuca*. I have found that all the attitudes about them being hard to rear are true, and only after many unsuccessful attempts have I been able to bring a good series of adults out. I have found that the larvae require absolute cleanliness and constant, fresh food. They also cannot be crowded, and I limit them to 10 larvae per container in the fifth instar. I use clear plastic quart jars that can be purchased inexpensively in any store, and drill holes in the bottom for the stems of the food-plant to be put into water. The larvae are very susceptible to disease, and several can be lost in a short time. I have reared all my larvae with no sunlight, but with abundant artificial light. When the larvae begin to roam about the bottom of the rearing container and take on a discolored appearance, I transfer them to another container for pupation. I use common "cat litter" as a pupating medium for all larvae, with tissues shredded on the top. This material seems to make very good pupal cells and is very mold resistant. The larvae usually burrow under the surface after a couple of days of roaming and pupate using the tissues as the top of the cell. The larvae frequently tend to pupate in groups, or near branches or twigs in the container. I wait two weeks after the last larva has burrowed before I gather the pupae; this allows enough time for all to pupate. Strangely, almost all the species in captivity begin emerging in July, although their natural flying period is September to November. This emergence continues off and on through October.

In summary, my rearing experiences with several *Hemileuca* species have supplied the following data to help answer questions in shadowy areas: *H. maia* will readily accept *Salix* as an alternate foodplant, at least in captivity; *H. e. electra* and *H. e. clio* have definite, consistent larval differences that support the idea of subspeciation, and the range of *H. e. clio* extends into the northern desert areas of southern California; and *H. burnsi* will accept *Prunus* in the wild or in the laboratory. I hope these data will aid in clarification of the status of the species and subspecies of this beautiful group and encourage others to rear the larvae.

With Ferguson's outstanding book for guidance, much more can be learned about *Hemileuca* through rearing and experimentation.

I wish to extend my sincere thanks to Christopher Henne, of Pearblossom, California, for his encouragement and education in life history work, and his kind review of this paper.

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MELANISM IN MOTHS OF CENTRAL MASSACHUSETTS (NOCTUIDAE, GEOMETRIDAE)

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The relative dearth of information on the incidence of melanism in North American moths has been recently noted (Kettlewell, 1973). Since the reviews of Owen (1961, 1962) called attention to increasing melanism in various bark-like noctuids and geometers, little else on North American species has been published. Owen & Adams (1963) analysed the occurrence of melanism in *Catocala ilia* (Noctuidae) in Michigan, and Klots (1964, 1966, 1968a, b) briefly noted increases in the frequencies of the melanic forms of *Charadra deridens* and *Panthea furcilla* (Noctuidae) in Connecticut. More recently, Sargent (1971) provided data on melanism in *Phigalia titea* (Geometridae) in central Massachusetts. The present data, acquired in the course of collecting moths for other studies in central Massachusetts from 1968-1973, are presented in hopes of stimulating others to acquire and publish similar data. Accumulated records, from different areas and at different times, may permit some meaningful geographic and historical comparisons, and so may contribute eventually to a thorough analysis of melanism in North America. Certainly every effort should be made to take advantage of our opportunity to study this phenomenon as it unfolds, for this opportunity may now be lost elsewhere in the world (Kettlewell, 1973).

TABLE 1. The numbers of typical and melanic individuals of *Panthea furcilla* taken in Leverett, Massachusetts (1970-1973).

Forms	Years				Totals
	1970	1971	1972	1973	
Typical	29	47	28	43	147
Melanic	35	94	40	73	242
% Melanic	54.7	66.7	58.8	62.9	62.2

METHODS

The records included here involve only those species which have been substantially sampled, as my experience indicates that general impressions from limited samples are unreliable as indicators of melanic frequencies. The six species on which I report were collected *in toto* over their entire flight seasons during the years indicated, and virtually all of the specimens have been retained in my collection.

Five of the six species considered were taken exclusively at light sources (incandescent, fluorescent black light, and mercury vapor). Most of these specimens were obtained in a Robinson trap (mercury vapor) which operated from dusk to dawn, and, as expected, most of the specimens from light sources were males. One species, *Catocala ultronia*, was taken at both lights and bait, but there were no differences between the two samples, or between the sexes in the bait sample, in terms of melanic frequencies in this case.

All specimens, unless otherwise indicated, were taken at my home in Leverett, Massachusetts. This collecting site is located in an extensive mixed deciduous woodland, most of which has grown up since a logging operation about 30-35 years ago. The dominant trees are oaks (*Quercus velutina* and *Q. alba*), with substantial representation of birches (*Betula papyrifera* and *B. lenta*), hickories (*Carya glabra* and *C. ovata*), pine (*Pinus strobus*), and hemlock (*Tsuga canadensis*). Some of the nearby area is more recently abandoned pasture, and is now in an intermediate stage of succession (sweet fern, *Comptonia peregrina*; juniper, *Juniperus virginiana*; gray birch, *Betula populifolia*; etc.).

Leverett is located some 75 air-miles west of Boston, 25 air-miles north of Springfield, and 66 air-miles east of Albany, New York. The collecting area shows little visible evidence of air-borne pollution, as lichens abound on tree trunks which are not noticeably darkened by soot. I have previously referred to the area as "ostensibly rural" (Sargent, 1971), in an attempt to give recognition to both its visible appearance and its location in the heavily industrialized northeastern United States.

TABLE 2. The numbers of non-melanic and melanic individuals of *Catocala ultronia* taken in Leverett, Massachusetts (1968–1973).

Forms	Years						Totals
	1968	1969	1970	1971	1972	1973	
Non-melanic	41	22	163	192	20	32	470
Melanic	7	7	22	47	5	10	98
% Melanic	14.6	24.1	11.9	19.7	20.0	23.8	17.3

RESULTS

Noctuidae

Panthea furcilla (Packard). The melanic form of this species, **atrescens** McDunnough, is easily distinguished from its typical counterpart by the black ground of the wings, though melanics do vary considerably in the extent of their white lines (see figures in Ginevan, 1971). The genetic basis of melanism has been studied (Ginevan, 1971), but further work is required, particularly to determine whether heterozygote and homozygote melanic males can be distinguished reliably by visual inspection. The numbers of typical and melanic individuals taken in Leverett from 1970–1973 are presented in Table 1.

Catocala ultronia Hübner. This highly polymorphic species has a strongly melanic form, **nigrescens** Cassino, with uniform, deep black forewings. This melanic was illustrated in Cassino's paper (Lepidopterist 1: 79, pl. vi), but is not shown in more popular works, such as Barnes & McDunnough (1918). The most common form of this species in Leverett is **celia** Hy. Edwards (Barnes & McDunnough, 1918: pl. VII, 18), but all of the non-melanic forms are considered together in the tabulation of collecting results (Table 2).

Catocala connubialis (Guenée). This generally rare moth has a "partly melanic" form, **pulverulenta** Brower, with nearly uniform grayish forewings; and a strongly melanic form, **broweri** Muller, with uniform, deep green-black forewings (see figures in Muller, 1960). Most of the

TABLE 3. The numbers of individuals of each form of *Catocala connubialis* taken in central Massachusetts (1970–1973).

Forms	Locations		Totals (%)
	Leverett	West Hatfield	
sancta	1	—	1 (3.3)
cordelia	2	3	5 (16.7)
pulverulenta	4	9	13 (43.3)
broweri	3	8	11 (36.7)

TABLE 4. The numbers of typical and melanic individuals of *Nacophora quernaria* taken in Leverett, Massachusetts (1971-1973).

Forms	Years			Totals
	1971	1972	1973	
Typical	3	10	11	24
Melanic	3	12	17	32
% Melanic	50.0	54.5	60.7	57.1

non-melanic specimens taken in this area are similar to, though darker than, **cordelia** Hy. Edwards (Barnes & McDunnough, 1918: pl. IX, 19), and occasional specimens are close to **sancta** Hulst (Barnes & McDunnough, 1918: pl. IX, 21). Due to the rarity of this species, the numbers of specimens of the various forms are summed for the years 1970-1973, and I have included specimens taken in a Robinson trap at West Hatfield, Massachusetts (7.5 air-miles from Leverett) by Charles G. Kellogg (Table 3).

Geometridae

Nacophora quernaria (Abbot & Smith). The melanic form of this species, **atrescens** Hulst, is jet black, with only occasional traces of faint whitish along the ordinary lines. Specimens splotched with white on a blackish ground were considered typical, as were all brownish specimens. This species is generally uncommon in Leverett, but the frequency of melanic individuals has been consistent (Table 4).

Biston cognataria (Guenée). Typical specimens of this species in Leverett are rather dark gray, being close to the **insularia**⁴ category of *Biston betularia* in England (Kettlewell, 1973: pl. 9.1, no. 2, left). The melanic form, **swettaria** Barnes & McDunnough, is nonetheless easily distinguished, being uniformly black over the entire wing surfaces (Kettlewell, 1973: pl. 9.1, no. 3, right). The numbers of typical and melanic specimens taken in Leverett from 1971-1973 are presented in Table 5.

TABLE 5. The numbers of typical and melanic individuals of *Biston cognataria* taken in Leverett, Massachusetts (1971-1973).

Forms	Years			Totals
	1971	1972	1973	
Typical	23	22	84	129
Melanic	—	1	5	6
% Melanic	—	4.3	5.6	4.4

TABLE 6. The numbers of typical and melanic individuals of *Phigalia titea* taken in Leverett, Massachusetts (1968-1973).

Forms	Years						Totals
	1968	1969	1970	1971	1972	1973	
Typical	125	135	131	189	117	123	820
Melanic	44	26	30	41	32	34	207
% Melanic	26.0	16.1	18.6	17.8	21.5	21.7	20.2

Phigalia titea (Cramer). The records presented here (Table 6) will up-date those previously reported for Leverett (Sargent, 1971). The typical and melanic form, **deplorens** Franclemont, of this species are illustrated in Remington (1958). Melanism in this species is very clear-cut; well over 1000 specimens have been taken, and only one or two of these were difficult to assign to either the typical or melanic form.

DISCUSSION

All of the species considered here presumably show industrial melanism, in the broad sense of that phrase. The melanics in these cases were extremely rare or absent in collections made prior to 1930 or 1940, and now they comprise substantial proportions of the existing populations. However, the generally held explanation of industrial melanism, as developed by Kettlewell through studies on *Biston betularia* in England (Kettlewell, 1958), seems not completely applicable to the present results. This explanation stresses the cryptic advantage of melanics on darkened tree trunks, but the trees in the Leverett study area are not noticeably devoid of lichens or blackened by soot. Many of the melanics taken there are extremely dark, nearly jet black, and would seem to be cryptic on only the darkest trees in heavily polluted areas. Furthermore, the apparent tendency of some of these melanics to prefer light backgrounds, like their typical counterparts (Sargent, 1969), makes an explanation for their occurrence based on cryptic advantage even less likely.

It is interesting to note that the frequency of melanics in *Biston cognataria* is quite low in Leverett, much lower, for example, than that occurring in New Haven, Connecticut (C. L. Remington, pers. comm.), or in the areas in Michigan sampled by Owen (1961). Perhaps *Biston* spp. are industrial melanics in much the sense that Kettlewell has proposed (1958), but recent data cast some doubt on the completeness of a cryptic advantage explanation for even *B. betularia* (Bishop, 1972; Lees, Creed & Duckett, 1973).

An activity of man which may have resulted in certain darkened backgrounds, and thus had an influence on at least one of the species considered here, is logging. This activity has been carried out periodically over most of New England since Colonial days, and one of the most prized timber trees throughout this period has been white pine, *Pinus strobus*, the foodplant of *Panthea furcilla*. If this moth tends to rest on the trunks of this tree, then a tendency of loggers to take the larger trees (with lighter, furrowed bark), and leave the younger trees (with darker, smooth bark), may have provided an ecological opportunity, in the form of more appropriate resting substrates, for melanic individuals.

Certain other species, notably *Phigalia titea* and *Nacophora quernaria*, which have rather high melanic frequencies in Leverett, suggest that various factors associated with industrialization, other than observable environmental darkening, should be investigated with respect to the incidence of melanism. For example, air pollution affects the physical and chemical characteristics of vegetation, and perhaps the larvae of melanics are better able than the larvae of typicals to tolerate such changes. Certainly, melanics have exhibited superior viability in a number of physiological tests (Ford, 1937, 1940). Industrialization has undoubtedly also had deleterious effects on the predators of insects, and perhaps relaxed selection pressures have allowed melanics to survive where they previously could not have survived.

All of the species considered here are bark-like cryptic species, and melanism in moths, particularly that associated with industrialization, has been largely restricted to such species. It is also generally true that melanism in those species studied is controlled by a single gene, with the allele for black being dominant to that for pale or typical coloration. These observations, together with our knowledge that the frequency of melanics may increase rapidly in a population, encourage some highly speculative ideas, which I will discuss very briefly.

Perhaps many bark-like species have been exposed throughout their histories to recurring situations where melanism has been advantageous. If so, these species may have evolved mechanisms which enable them to change quickly from prevailingly pale to prevailingly dark populations. Such changes might be effected through conditional genes for melanism, i.e. genes which are expressed only under conditions that are associated with environmental darkening. Among such conditions might be the chemical or physical effects of forest fires on the insects or their foodplants. The ability of a species to respond to these effects by producing adult melanics, which would then be cryptic on blackened backgrounds, could give it a clear selective advantage. Perhaps then,

industrialization is creating conditions which are similar, or identical, to conditions created historically by forest fires. Melanic forms, in this event, would be somewhat analogous to the various seasonal forms which characterize many lepidopteran species.

Much of this discussion is clearly fanciful speculation, but perhaps some excesses of this sort may be excused, if the result is to suggest that our understanding of industrial melanism is far from complete.

SUMMARY

Six species of bark-like moths with melanic forms were extensively sampled in central Massachusetts between 1968 and 1973. These species, and the percentages of melanic individuals in the sampled populations, are: *Panthea furcilla* (62.2%), *Catocala ultronia* (17.3%), *Catocala connubialis* (36.7%), *Nacophora quernaria* (57.1%), *Biston cognataria* (4.4%), and *Phigalia titea* (20.2%). These results are discussed with reference to various theoretical and speculative views on the phenomenon of industrial melanism.

ACKNOWLEDGMENT

I thank Charles G. Kellogg for allowing me to use his unpublished data on *Catocala connubialis*.

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BIOLOGY AND IMMATURE STAGES OF *SCHINIA MITIS* (GROTE) (NOCTUIDAE)¹

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Schinia mitis (Grote) occurs from central Florida, north to Georgia, and west to eastern Texas (Hardwick, 1958). Most of the specimens Hardwick examined were collected in April, May, and June, but a few were collected in September and November. Kimball (1965) listed Florida records from March to June. Forbes (1954) gave the foodplant as *Sitilias caroliniana* Walt. [= Carolina false dandelion, *Pyrhopappus carolinianus* (Walt.) DC]. Hardwick (1958) figured the lateral aspect of the egg and design of the chorion and gave a description and dimensions based on eggs dissected from preserved or dried females. Ganyard & Brady (1972) reported that males were attracted to virgin females of Indian meal moth, *Plodia interpunctella* (Hübner); almond moth, *Cadra cautella* (Walker); and fall armyworm, *Spodoptera frugiperda* (J. E. Smith), in field studies at Watkinsville, Georgia. No other published information was found on this species.

¹ Florida Agricultural Experiment Station Journal Series No. 5035. Received for publication.

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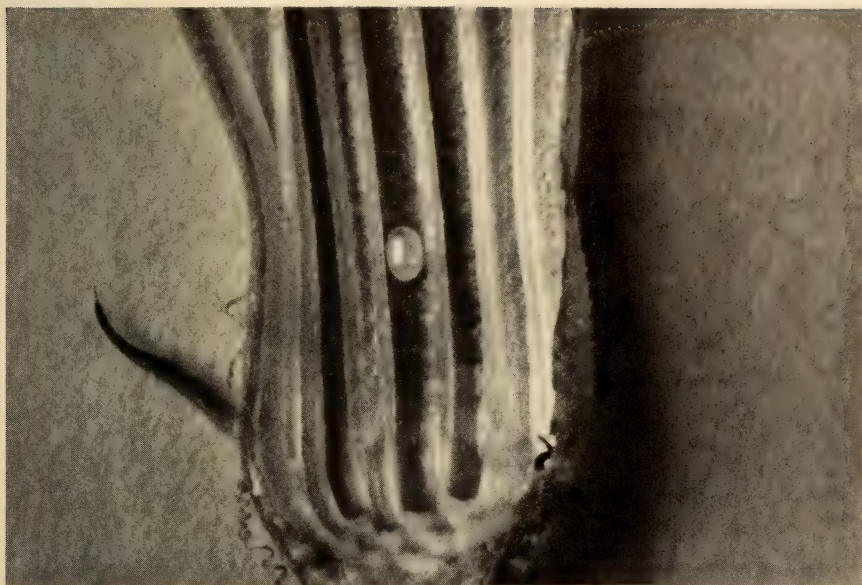


Fig. 1. *Schinia mitis* egg on inside of involucre of *Pyrrhopappus carolinianus* (Walt.) DC.

Schinia mitis is a day-flying heliothidine moth. It is active only for a few hours in the morning when the flowers of the Carolina false dandelion are open. Moths fly rapidly from flower to flower but are easily netted while on a flower. On hot sunny days, all the flowers may be closed by 1000, whereas on cooler cloudy days, flowers may remain open until about noon. When the flowers are closed the moths usually rest facing downward on the stem or side of the receptacle. Occasionally, a moth was observed resting head downward in a flower. Mating apparently occurs on open flowers since mating pairs were frequently observed there from about 0700 to 0945, although mating probably also occurs earlier. Ovipositing females extend their abdomen downward between the florets and deposit eggs either on the developing ovaries or more often on the inside of the involucre (Fig. 1).

During 1967, flowers of the Carolina false dandelion began to appear in late February in the Gainesville area; and a few blooms were observed as late as October. Most flowers appeared between mid-April and mid-June. Flowers collected on 18 and 24 March contained no larvae, but some eggs were found in the latter collection. Thereafter weekly collections consisting of 150 flower heads (50 open, 50 closed yellow, and 50 closed white) were made through 11 August, and all samples con-

TABLE 1. Seasonal distribution and abundance of *Schinia mitis* eggs and larvae in weekly collections of flowers of Carolina false dandelion, Gainesville, Florida, 1967.

Date	50 Open Flowers		50 Yellow Closed Flowers		50 White Closed Flowers	
	Eggs	Larvae	Eggs	Larvae	Eggs	Larvae
III-31	15	0	15	2	3	14
IV- 7	25	3	19	4	0	12
-14	5	2	1	0	1	6
-21	1	2	2	12	0	3
-28	29	0	15	3	0	19
V- 5	30	1	19	23	0	38
-12	6	4	4	17	0	31
-19	19	3	11	7	0	8
-26	36	3	12	5	0	30
VI- 2	7	1	6	8	0	30
- 9	2	0	4	4	0	20
-16	19	1	15	2	0	12
-23	6	0	13	9	0	21
-30	16	0	13	3	0	1
VII- 7	7	2	2	7	0	15
-14	0	0	2	0	0	4
-21	0	0	0	1	0	2
-28	0	0	0	0	0	4
VIII- 4	23	0	17	1	0	21
-11	0	0	1	0	0	8
Totals	246	22	171	108	4	299

tained eggs and/or larvae of *S. mitis* (Table 1). Flowers became scarce after that and partial samples collected on 18 and 30 August and on 22 September were negative. This agrees with the results of Ganyard & Brady (1972) at Watkinsville, Georgia (ca. 300 mi NNW of the Gainesville area) where no *S. mitis* males were collected in traps placed in the field after about 10 September.

Open flower heads contained mostly eggs, but almost no eggs were found in the closed white heads, although larvae were common there. In the yellow closed heads, both eggs and larvae were commonly found. This is not surprising in view of the development of both the insect and the flower. Sixty flower buds were tagged and checked daily to determine the flowering period. Each flower was open only 2-3 days followed by a closed period during which the seeds developed. During this closed period, the flower heads could be separated into a yellow phase (1.5-3.0 days) and a white phase (4.0-7.5 days) after which the head opened up and the seeds were blown away. Therefore, since oviposition cannot occur until the flowers open and the eggs do not

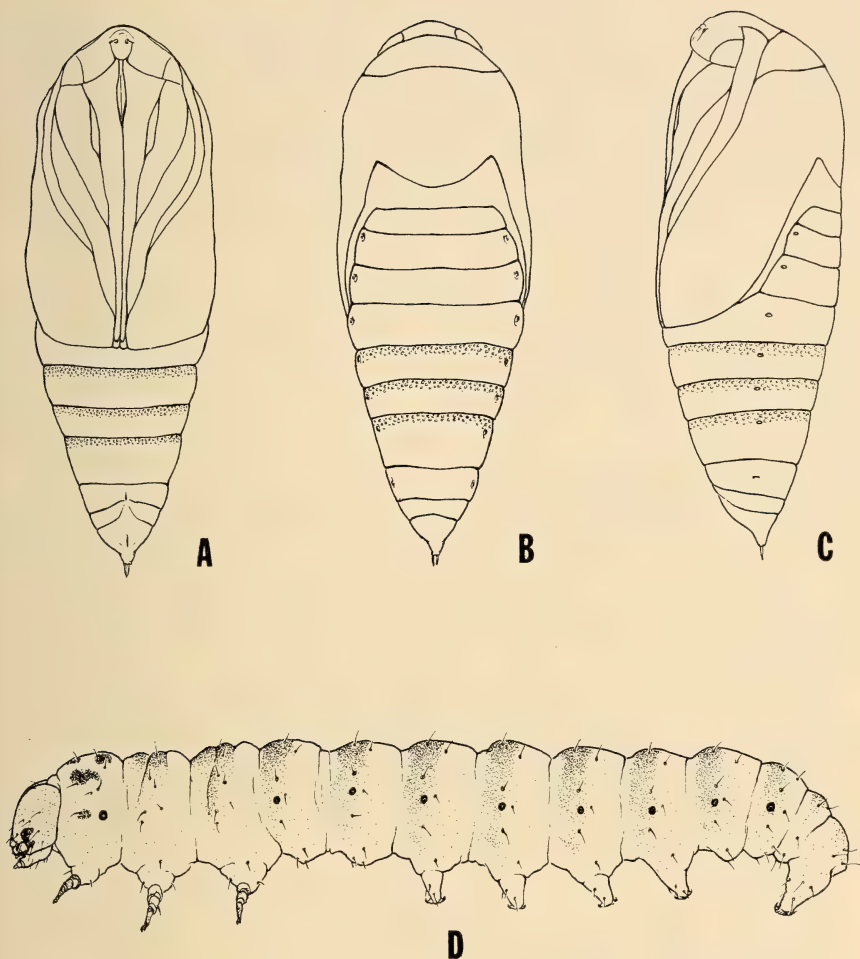


Fig. 2. Pupa and larva of *Schinia mitis*: A, B, C. ventral, dorsal and lateral view of female pupa; D. lateral view of mature larva.

hatch until the flower closes, there are only about 10 days in which the flower head is available for food. Since larval growth required a minimum of 13 days, the larvae must inhabit at least two flowers to complete their development. Large larvae were occasionally observed in open flowers or yellow closed flowers in the field.

The sex ratio of 43 moths collected from flowers between 10 May and 30 June was nearly 1:1 (21 ♂, 22 ♀). Of 19 females examined, all had mated: 14 once, 4 twice and 1 three times. Four of the females contained over 40 fully developed eggs, with one having 75.

On 2 occasions vespid wasps were observed burrowing into flower heads. On each occasion, when the wasp withdrew it was dragging a mature larva which it promptly stung. One of the wasps was captured and identified as *Pterocheilus texanus* Cresson. Predation by these and possibly other wasps apparently was not unusual since flowers were seen frequently that had been torn open in a similar way. The only other enemy observed was a crab spider, *Mimusops* sp., which had captured an adult moth on an open flower.

Life History

Eggs were collected from field flowers and placed singly in test tubes with whole or partial flowers and kept at 25° C and 14:10 light:dark photoperiod. All field collected eggs hatched within 3 days. Although 24 larvae were reared to the pupal stage, only 18 emerged as adults, the others apparently entering diapause. The larval stage required 13–18 days (avg. 15.3) and the pupal stage 9–17 days (avg. 12.9). Daily observations of 11 individuals revealed eight with 4 larval instars and three with 5 instars. The average duration of the stadia was 3.4, 2.4, 2.4, and 7.0 for 4 instars and 4.3, 2.0, 2.0, 2.0 and 7.0 days for 5 instars. Development from hatching to adult emergence required 22–32 days (avg. 28.0).

Egg (Fig. 1). Light green, closely matching color of inside of involucre. Color fairly constant at least until larva inside becomes visible. Dimensions of egg: length 0.71 ± 0.03 mm, width 0.48 ± 0.03 mm (23 eggs).

Larva. Spicules, which become progressively more conspicuous in later instars, present on bodies of all larvae. Spicules pale except in reddish transverse bands where they are black.

First Instar. Head capsule width: 0.39 ± 0.03 mm ($n = 29$). Head pale yellowish-brown. Ocellar area dark brown. Body yellowish-white. A faint yellowish-pink transverse band present on metathorax and abdominal segments 1–8 in some specimens. Prothoracic shield, thoracic legs, anal shield, lateral sclerites on prolegs, and pinacula grayish-brown.

Second Instar. Head capsule width: 0.65 ± 0.04 mm ($n = 28$). Head light brown suffused with slightly darker markings. Ocellar area dark brown. Frons and adfrontals often lighter. Body pale orange except for whitish prothorax. Whitish spot dorsad and ventrad of seta D2 on abdominal segments. Prothoracic shield dark brown with 4 irregular incompletely separated black spots. Thoracic legs and pinacula dark brown. Anal shield and lateral sclerites on prolegs grayish-brown.

Third Instar. Head capsule width: 1.05 ± 0.06 mm ($n = 29$). Head yellowish-brown, suffused with light brown markings. Ocellar area dark brown to black. Body reddish-brown, except lateral aspects of 10th abdominal segment whitish. Each abdominal segment with whitish spot dorsad and ventrad of seta D2. Metathorax with similar whitish spots plus a whitish subspiracular spot which is also present on abdominal segments 1 and 2. On mesothorax a whitish spot ventrad of seta D2 forms a whitish line extending anteriorly to the prothoracic shield. Prothoracic shield white with 6 black spots. Thoracic legs grayish-brown. Pinacula grayish-brown to brown. Lateral sclerites on ab-

dominal prolegs light grayish-brown. Anal shield and lateral sclerites on anal prolegs dark grayish-brown.

Fourth and Fifth Instar (Fig. 2 D). Head yellowish-brown suffused with light brown markings. Frons and adfrontals paler. Ocellar area black. Body creamy white with maroon transverse band on anterior half of meso- and meta-thorax and abdominal segments 1-9. Bands on mesothorax and 9th abdominal segment noticeably paler. Prothoracic shield whitish with 6 irregular black spots. Thoracic legs pale basally gradually darkening to grayish-brown on tarsus. Anal shield pale yellowish-brown. Spiracles dark brown with black peritreme. Pre-spiracular sclerite black, pinacula brown.

Pupa (Fig. 2 A, B, C). Lightly sclerotized, light orangish-brown. Spiracles in shallow depression, rims of spiracles projecting above cuticular surface. Anterior margins of abdominal segments 5, 6, and 7 strongly pitted. Proboscis length variable, exposing metathoracic legs as figured or extending completely to apex of wings. Cremaster consisting of 2 elongate spines curving slightly ventrad.

ACKNOWLEDGMENTS

The assistance of Mrs. Sandra Shuler in various phases of this study and of Mrs. Phyllis Habeck for the illustrations is gratefully acknowledged. Identification of the wasp was by Dr. Eric Grissell and the spider by Dr. Karl Stone.

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A FURTHER FIELD NOTE ON *ISOPARCE CUPRESSI* (SPHINGIDAE)

A description of the larva of *Isoparce cupressi* (Bdv.) was given by the author (1973, J. Lepid. Soc. 27: 1-8), accompanied in the same issue by a field note by Van Buskirk (p. 83-84). Both articles omitted mention of a larval character brought to notice in the caterpillars collected by Van Buskirk near McClellanville, South Carolina. In my description of the development of the larva, much attention was given to the brown on the dorsal stripe and on the spiracular areas. In Van Buskirk's specimens, many of them showed no such brown except for the dorsal horn and on the second thoracic spiracle. Instead, the areas mentioned showed the same yellowish white of the lateral lunules. All degrees between the two extremes were seen in the wild larvae. Van Buskirk's wild caterpillars included various instars collected over a very few days, and so represented the offspring of several different females, leading to the conclusion that the natural coloration of the larva is variable in this respect.

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BIBLIOGRAPHIC NOTE ON POEY'S *CENTURIE DE
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Of the ten butterfly names proposed or treated by Phéliepe Poey in his *Centurie de Lépidoptères de l'ile de Cuba* (1832), three are today applied to species occurring in the Nearctic fauna: "*Terias*" [*Eurema*] *dina* Poey, "*Eumenia*" [*Eumaeus*] *atala* Poey, and "*Melitea*" [*Phyciodes*] *frisia* Poey. In only the last species is the nymotypical race Nearctic. Three other names, "*Polyommatus*" [*Hemiargus* *hanno*] *filenus* Poey, *Pieris ilaire* Godart [= *Appias drusilla* (Cramer)], and "*Callidryas*" [*Phoebis*] *orbis* Poey, have in the past been applied to North American butterflies.

There is general lack of agreement among catalogues of North American butterflies in citing this work. Although Poey illustrated only a single species on each plate, in some references as many as three species are given the same plate number. These discrepancies are readily observed in Table 1, which contains exact quotations of the citations of the work by various catalogue compilers.

Poey's work was issued in parts, with unnumbered pages and plates, which were intended to be rearranged, numbered and bound on completion of the work, but it was never finished; only two of the ten projected decades of ten species each were issued. The work was recently ("1970" [1971]) reprinted by E. W. Classey Ltd. Colonel Charles F. Cowan informed me (*in litt.*) that he has seen three original copies of Poey, the one that was reproduced by Classey and two others, and in all the order of species is the same. However, copies exist in which the species are arranged differently. Through the kindness of Ms. Carolyn Jakeman of the Houghton Library of Harvard University, such a copy was located in that library. The arrangement of species in this copy is shown in Table 1.

Cowan (*in litt.*) suggested that the discrepancies noted may have resulted from the use of such a differing copy by an early author, possibly Scudder, and the repetition, without checking, of his references by subsequent compilers. The rarity of Poey's work may have prevented these normally careful authors from checking their references. The Classey text, agreeing in arrangement with most originals, will probably be accepted as definitive.

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TABLE 1. Arrangement of species in 3 originals and Classey reprint of Poey (1832), in Harvard University copy of Poey, and citations of this work by various catalogue compilers.

Works	Species					
	<i>Callidryas orbis</i>	<i>Melitea frista</i>	<i>Eumenia atala</i>	<i>Terias dina</i>	<i>Polyommatus filenus</i>	<i>Pieris ilatre</i>
Poey 1832 (3 originals and Classey reprint)	pl. [1] pp. [1-3]	pl. [2] pp. [5-6]	pl. [3] pp. [7-9]	pl. [12] pp. [35-36]	pl. [13] pp. [37-38]	pl. [16] pp. [43-44]
Poey 1832 (Harvard copy)	pl. [1]	pl. [2]	pl. [3]	pl. [11]	pl. [13]	pl. [12]
Scudder 1875-1876	—	2nd Dec.	I [5-7] pl. 2	—	2	—
Edwards 1877	pl.	pl. 2	pl. 2	—	pl. 2	pl.
Strecker 1878	—	p. 9, t. 2	t. 2	[Attributed to Hübner]	t. II	—
Edwards "1884" [1885]	pl. 1	9 pl. 2	pl. 2	—	pl. 2	pl. 19
Skinner 1898	—	9, pl. 2	t. 2	[Attributed to Hübner]	pl. 2	pl. 19
Dyar "1902" [1903]	—	9	ii	[Attributed to Hübner]	—	—

I gratefully acknowledge assistance provided by F. M. Brown, Lee D. Miller, and particularly Col. C. F. Cowan, whose ideas and suggestions are largely embodied in this note.

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MORTALITY IN A GROUP OF *MEGATHYMUS YUCCAE* (MEGATHYMIDAE)

Megathymus yuccae yuccae (Boisduval & Le Conte) was described in 1833 from Aiken County, South Carolina. This skipper was known in South Carolina only from the type locality until March 1971, when I located a small colony along Hwy. 174 south of Adams Run in Charleston County. In the spring of 1972 I found a very large colony at Edisto Island State Park in Charleston County. This area is 12 miles from the Adams Run colony. In 1973, three empty "tents" were found in a stand of yucca plants northeast of Mt. Pleasant along Hwy. 17 again in Charleston County. Dr. Douglas C. Ferguson captured a female on 4 April 1971 at the Wedge Plantation, Charleston County and Dr. Dominick collected two males there on the same date. In 1973 Dr. Dominick found a pupal tent in the same area, dug it up, acquired a live pupa and freeze dried it. The Edisto Island locality and the Wedge Plantation locality are at opposite ends of Charleston County, approximately 70 miles apart. The Mt. Pleasant area is approximately in the middle of the county. Thus *Megathymus yuccae* appears well established in coastal Charleston County.

In February of 1973 I decided to visit Edisto Island and dig up pupae of *M. yuccae*. This was done in the middle of February, which was a month earlier than I had ever dug up *M. yuccae* before. (By February the larvae of *M. yuccae* have stopped feeding and tend to stay in the upper portions of the hostplant. A few days before the larvae pupate they stop moving in the typical "caterpillar" motion

and start propelling themselves up and down the tunnel in the cortex of the plant by rotating their abdomen, as is the character of the pupae.) I found several plants which had the tents of *M. yuccae* in them and started to dig. After I had dug up 10 plants I decided to stop and come back at a later date to dig up the rest because I had found only 2 pupae, the rest being still in the larval state. Six of the 8 larvae were ready to pupate, the other two had discontinued feeding but were still active. On 17 and 18 March I again visited Edisto Island and dug up 25 more immatures. Of the 25 in the March batch only 3 were still larvae, the rest having already pupated. All 3 larvae were ready to pupate.

I divided all of the immatures into two groups: group A (being those which were found in February); and group B (those found in March). Group A consisted of 8 larvae and two pupae. Of the 8 larvae, 2 died in that state; the rest pupated but of these only two emerged as perfect adults, both females on 22 March. The other four emerged (3 males, 1 female) but the wings did not expand. Of the two pupae, one emerged a perfect male on 16 March. The other pupae had died when checked on 16 March.

Group B consisted of 22 pupae and 3 larvae. Of the three larvae, 2 had died when checked on 9 April. The other pupated, and a perfect female emerged on 11 April. Of the 22 pupae, four died while 16 emerged as perfect adults (9 males on 21, 24, 26 (2), & 27 March and 8, 9 (2), 12 April; 7 females on 25, 29 March and 14, 15, 19, 20 and 21 April). Two others emerged but their wings did not expand (1 male, 1 female).

The total sample of 11 larvae breaks down as follows: 4 died (36.5%) and 7 pupated (63.5%). Of those which pupated, only 3 emerged as perfect adults (43%) and 4 emerged deformed (57%). Of the 24 immatures which were taken in the pupal state: 5 died (21%), 17 emerged as perfect adults (71%), and 2 emerged deformed for 8%. In all, 17 of 24 pupae succeeded in reaching the perfect adult state (71% success). On the other hand only 3 of 11 larvae taken emerged as perfect adults (73% failure).

The conclusion is obvious, if you plan to collect *Megathymus yuccae* by digging up the immatures you will have far better success if you wait until the larvae have pupated. 71% success is better than 73% failure any day. It will be interesting to see if this mortality rate occurs in other species of *Megathymidae* as well.

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SOUTHERN RECORDS OF *MITOURA HESSELI* (LYCAENIDAE)

When *Mitoura hesseli* (Rawson & Ziegler) was recognized as a new species from Lakehurst, New Jersey in 1950, several specimens from North Carolina were found by the late Frank Morton Jones in his collection. Since their capture in 1911, these had been assumed to be *Mitoura gryneus* (Hubner). These specimens (two males and two females) were captured on 28 July near Southern Pines in Moore Co. To my knowledge these are the only records from North Carolina. Therefore I was excited when I found *M. hesseli* at two locations in North Carolina during 22-25 July 1972. The two locations, one on the Ft. Bragg Military Reservation and the other near the town of Raeford, are in Cumberland and Hoke counties respectively. Both of the counties border on Moore Co.

I tried to find *M. hesseli* in April 1972 by visiting a number of the more accessible

concentrations of White Cedar (*Chamaecyparis thyoides*) on the Ft. Bragg reservation, but had no luck, and decided not to make an effort to look for the second brood. In July I was collecting hesperids that were visiting Sweet Pepperbush (*Clethra alnifolia*) when I spotted and captured the first *M. hesseli* also visiting these flowers. After realizing what I had captured, I made a quick search of the area and found a small stand of White Cedar (10–12 trees) about 20 yds. from the edge of a powerline cut in which I was collecting. More White Cedar may have been farther back in the wooded area. An hour's worth of additional searching turned up 2 more specimens.

Having found my first *M. hesseli* I checked other promising stands of White Cedar and eventually found the second locality. The two areas in which *M. hesseli* were found were the only areas that had a considerable amount of Sweet Pepperbush in the vicinity of the White Cedar. I tried tapping trunks and throwing sticks into the upper branches of the White Cedar, but never saw *M. hesseli* on its foodplant. In both areas *M. hesseli* was uncommon, and a two hour search would turn up 4–5 specimens. The patches of Sweet Pepperbush could be searched in 10–15 minutes so that most of the time was spent just waiting for *M. hesseli* to appear on the flowers. Most collecting was done during midday, however, some specimens were taken as late as 1700, and almost all were in good condition.

White Cedar is not uncommon along stream banks and in swamps in this part of North Carolina, and in view of the fact that the captures were made over a three county area separated by as much as 23 air miles, further collecting in this part of the state should turn up additional locations. Also it seems that the most promising areas to investigate, in July at least, would be those where Sweet Pepperbush or other productive flowers are in the vicinity of White Cedar.

It is interesting to note similarities in the occurrence of *M. hesseli* in North Carolina and in New Jersey. Rawson & Ziegler (1950, J.N.Y. Entomol. Soc. 58: 69–80) noted that *M. hesseli* in New Jersey was almost always found on flowers, and was not seen arriving or leaving, or flying about the foodplant as does *M. gryneus*. This certainly was the situation in North Carolina.

The range of *M. hesseli* has now been extended to Virginia with the capture of a female on 18 July 1972 in Chesapeake. Mr. Bill Smith captured the specimen on milkweed (*Asclepias syriaca*), along with a female *M. gryneus*, while collecting on the eastern edge of the Dismal Swamp.

There appears to be an unpublished record of *M. hesseli* from Maryland. In the correspondence of Mr. Frank Jones to Mr. J. B. Ziegler regarding the identification of *M. hesseli* in his collection, Jones cited a specimen from Pocomoke, Maryland, dated only 21 July and bearing a dos Passos identification label. The present status of the specimen or why the record has never been published before is unknown.

M. hesseli may occur in many areas along the coastal region of the eastern U.S., but probably has remained uncollected not only because White Cedar often grows in inaccessible swamp lands, but also because *M. hesseli* is inconspicuous in areas where it does occur.

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AN ABERRANT INTERSPECIFIC HYBRID OF *LIMENITIS* (*NYMPHALIDAE*) FROM WISCONSIN

Interspecific hybrids between the *Limenitis arthemis-astyanax* complex and *Limenitis archippus* (Cramer) are extremely rare in nature. They occur as morphs preserving either more *artemis*-like (*arthechippus* Scudder) or *astyanax*-like (*rubidus* Strecker) phenotypic characters. Each of these can be generally separated into two sub-

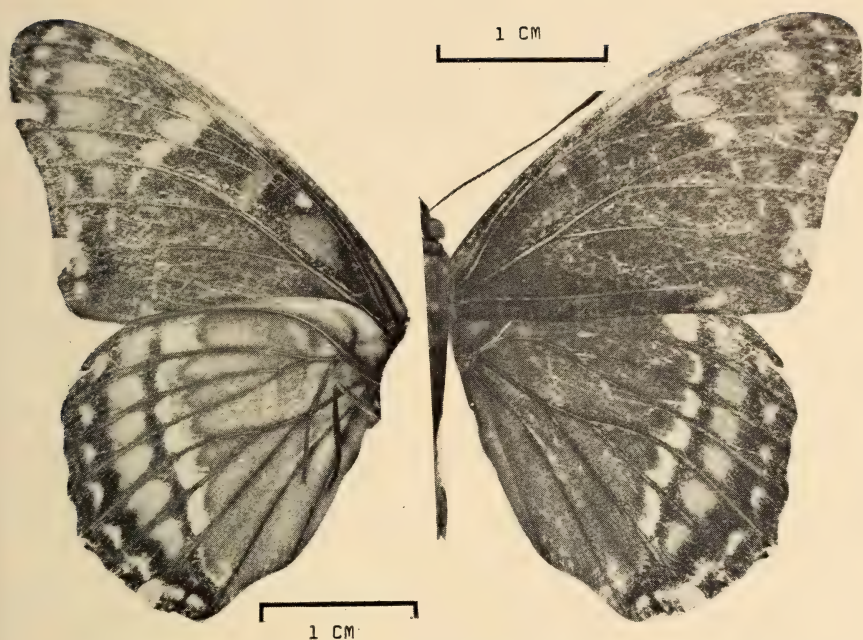


Fig. 1. *Limenitis f. arthechippus* from Stevens Point, Wisconsin. Right: right wings, dorsal; Left: right wings, ventral. Note that the photos are not exactly to same scale.

morphs, light and dark. These interspecific hybrids have been reviewed by Platt, Frearson & Graves (1970, Can. Entomol. 102: 513-533) and Platt & Greenfield (1971, J. Lepid. Soc. 25: 278-284).

An interspecific male hybrid of *Limenitis*, representing a ninth wild-caught Nearctic record of the hybrid morph *arthechippus* was captured by James M. Malick at Stevens Point (Portage County), Wisconsin, on 8 August 1961. It has been noted in a regional faunal study (Johnson & Malick 1972, Reports on the Flora and Fauna of Wisconsin 7: 1-6) and deposited in the Museum of Natural History, University of Wisconsin, Stevens Point. Unfortunately, the genitalia of the specimen were accidentally destroyed after examination. The purpose of this paper is to report and describe the specimen, and speculate about what type of cross it represents.

Platt & Brower (1968, Evol. 22: 699-718) and Platt, Frearson & Graves (op. cit.) have demonstrated that banded *L. a. arthemis* (Drury) and unbanded *L. a. astyanax* (Fabricius) are conspecific. Intergrades of this complex show continuous variation which may be divided into six categories. Categories 1 and 6 are the respective parental types; categories 3 and 4 are partially banded morphs referable to the form name *proserpina* Edwards; and categories 2 (banded) and 5 (unbanded) are more applicable to the name of each parent type. Genetic studies to date support the hypothesis that the white banding of *arthemis* is controlled by a major autosomal gene, the alleles of which display incomplete dominance (A. P. Platt, pers. comm.). Platt & Brower (op. cit.) have suggested that this complex exhibits primary, rather than secondary, intergradation, and that their populations in the "blend zones" are held in Hardy-Weinberg equilibrium by the neutralizing effects of selection favoring mimicry (*astyanax*) in southern regions and disruptive

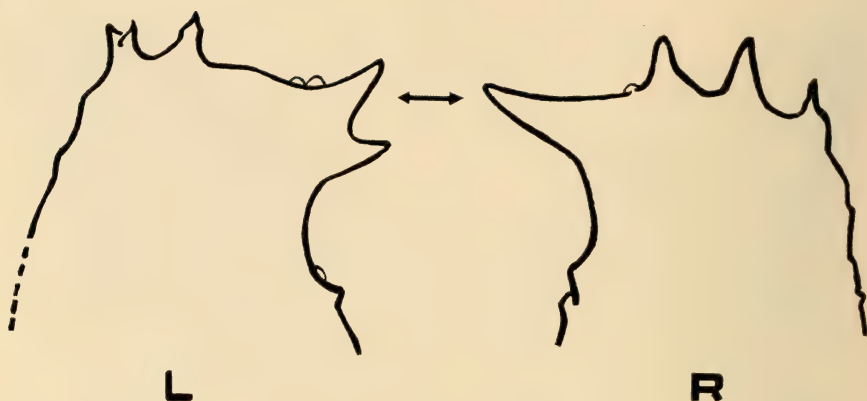


Fig. 2. Distal ends of the valvae, outer lateral view: L (left), R (right). The "hybrid" spines are indicated by the arrows.

coloration (*arthemis*) northward. The intergrade forms presumably survive through some selective advantage of partial banding within the region where these selective forces become reversed (A. P. Platt, pers. comm.).

Random sampling of the genus at the approximate latitude of 44°32' in Portage and Clark counties in Wisconsin indicates a ratio of 0.79 banded (*arthemis*)/0.08 partially banded (*proserpina*)/0.13 unbanded (*astyanax*) for 24 specimens. This latitude is far enough north to expect the scarcity of the latter two morphs. A recent sampling of 100 specimens at Minneapolis, Minnesota (approx. latitude 45°) (Bergman & Masters 1971, Mid-Continent Lepid. Ser. 2(31): 1-11) reflects a respective ratio of 0.58/0.20/0.22 for the three forms. *L. archippus* is commonly represented in samples taken from the exact collecting locality of the Stevens Point hybrid.

The Stevens Point hybrid (Fig. 1) is unusual because its coloration seems most like that of a *proserpina* intergrade. This was the tentative identification given it by Dr. Platt (from color slides) after its discovery. Only the subsequent genitalic dissection confirmed that the specimen is referable to *arthechippus*. Interestingly, the coloration of the wings is very similar to a group of *proserpina* noted as "form (c)" in an early review by Field (1904, *Psyche* 11: 1-6). Such specimens of *proserpina* are large, brown in ground color, have narrow and irregular mesial bands, and show prominent red spots on the surface of the secondaries. The new Wisconsin hybrid is large (wing-span = 5.6 cm) and its most distinctive character is the extremely dark ground color of the wings, like that of *proserpina*. The mahogany coloring so characteristic of other interspecific hybrids is reduced.

Outline drawings of the distal ends of the valvae (Fig. 2) were traced from photos taken before the dissection was sent to Dr. Platt. He confirmed the dissection as *arthechippus*. Each valva clearly shows a distal downward pointing, blunted spine representing the intermediate condition between the short teeth of the *arthemis-astyanax* complex and the long downward curving and pointed spine characteristic of *archippus* (see Chernock 1950, *Amer. Midl. Nat.* 43: 513-569; Nakahara 1924, *Bull. Brooklyn Entomol. Soc.* 19: 166-180; and Platt, Frearson & Graves, op. cit., Fig. 3). This evidence confirms that the present specimen is an interspecific hybrid. The spine is bifurcate on the left valva, whereas, the right one is somewhat longer and narrower than that figured by Platt, Frearson & Graves (op. cit.). Further research on variability in the distal spines of these interspecific hybrids might link certain morphological characters with specific genotypes.

The Stevens Point specimen represents an aberrant morph, when compared to lab-reared or other wild-caught interspecific hybrids of *Limenitis*. The aberrant phenotypic characters of this specimen suggest that it might represent a case of natural hybridization between an intergrade of the *arthemis-astyanax* complex and *archippus*, or possibly the backcross of a male *arthechippus* to the *arthemis* parent (no females of *arthechippus* are known, presumably due to heterogametic inviability).

Two recent interspecific crosses of female *proserpina* intergrades with *archippus* males in the laboratory have produced a 1:1 ratio of *arthechippus* and *rubidus* siblings (A. P. Platt, pers. comm.). However, the above sampling ratios, and possibly the reduction of mahogany ground color in the wild hybrid, suggest that the latter speculation is more probable.

I am greatly indebted to Dr. Austin P. Platt, University of Maryland Baltimore County, for suggestions, materials, verifications, and review of the manuscript. Thanks are also due to Dr. Charles A. Long, Director of the Museum of Natural History, University of Wisconsin, Stevens Point, and Mr. Peter L. Borgo, University of Delaware, for their consideration and comments. Father Roy Parker, Holy Cross, inked the drawings.

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EXTENDED RANGE DISTRIBUTION NOTES ON GEOMETRIDAE

Ten years of collecting moths in the Midwest has resulted in many interesting and unusual captures. Some of these species appear to be far out of their previously recorded ranges and these records may prove to be of interest to the researcher and collector alike. Among the most notable of these are *Itame abruptata* (Walker) a northern species previously known to occur in Canada and Northeast United States which was taken in Franklin Co., Missouri (5 and 7 June 1972), and in Washington Co., Missouri (6 June 1972) (several fresh specimens of both sexes); *Euchlaena irraria* (Barnes & McDunnough) another northern species before only known from Canada and as far south as Pennsylvania which was taken twice in Washington Co., Arkansas (27 May 1967 and 1972), and once in Franklin Co., Missouri (6 June 1972) (all fresh males); *Glena cribitaria* (Guenée) an eastern species with the nearest previous record from its type locality of Northern Illinois was taken several times in Carroll Co., Arkansas (May 1965), Washington Co., Arkansas (April 1967, May 1966-9 and June 1971), Benton Co., Missouri (May 1970), and Washington Co., Missouri (June 1973) (in fresh series of males and females); *Lyttosis sinuosa* Rindge an eastern species with its nearest previous record from Oktibbeha Co., Mississippi was taken in Washington Co., Arkansas (4 June 1971, 27 May 1972) (fresh males), and Franklin and Washington Co., Missouri (5-7 June 1972) (in fresh series of males and females); *Chloroteryx tepperaria* (Hulst) a species of the Gulf States was taken in Washington Co., Arkansas (1 September 1968) (a single male), and 21 August 1971 (three fresh males); and *Heterophleps refusata* (Walker) a northern and eastern species previously taken as far south as Virginia was taken twice in Clay Co., Missouri (29 May 1968, 4 May 1972), and once in DeKalb Co., Missouri (21 June 1972) (all fresh males).

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A NOTE ON HABITAT AND GEOGRAPHY

Based upon correspondence and conversations with collectors around the country, it would appear that many lepidopterists have only vague ideas concerning butterfly habitats in regions other than their home areas, unless they have traveled widely. The purpose of this note is to point out that for a given species, extensive habitat variation may occur as a function of geography. To understand butterfly distributions and subspeciation, collectors need to be aware of the interrelations among latitude, longitude, and altitude, as well as the more obvious factors such as annual mean temperature, rainfall and vegetation. A useful reference in these areas is Carpenter's book (1956, *An Ecological Glossary*, Hafner, New York).

To emphasize my point, several anecdotes and experiences are presented herein. It was once remarked to me that Laramie, Wyoming, my present home, with its elevation of 7100 ft. should be rich in arctic-alpine (tundra) species. When I asked why, the reply was that the top of Mt. Washington in New Hampshire is tundra at 6200 ft. and is populated by such species as *Oeneis melissa semideia* (Say) and *Boloria titania montinus* (Scudder). My eastern friend had neglected several factors. Laramie is a few degrees in latitude south of Mt. Washington and unlike New Hampshire, has an annual average rainfall of from 10 to 14 inches. The life zone is Upper Sonoran Desert or Bush-Steppe, Northwest Semi-Desert with mixed grasses and sagebrush as principal vegetation types.

At Wyoming's latitude (41° to 45° N), tundra or paramos occurs only above 10,000 ft. As one travels north along the Rocky Mountains, tundra appears at lower elevations: about 6500–7000 ft. near Banff, Alberta (ca. 52° N) and 3000 ft. north of Fairbanks, Alaska (ca. 65° N). In this region of the Northwest, the longitude variation is from 105.5° W at Laramie to 145° W at Eagle Summit, north of Fairbanks. By contrast, along the northeast coast (64° to 72° W), tundra occurs on Mt. Washington (6288 ft., 71.25° W, 44.25° N), Mt. Katahdin, Maine (5268 ft., 68.9° W, 45.9° N), Mt. Albert, Gaspé, Quebec (ca. 4700 ft., 66° W, 49.5° N). At Churchill, Manitoba, arctic tundra occurs at sea level (ca. 94° W, 59° N).

The various subspecies of *Oeneis melissa* are tundra dwellers, whether they be found at high altitudes in the Rocky Mountains, or low altitudes in the Northeast and Far North. One cannot always make habitat projections of this nature, however. In Maine and Quebec, and west through Minnesota, then North to the Northwest and Yukon Territories into Alaska, the subspecies of *Oeneis jutta* (Hübner) are generally associated with muskeags (bogs), although in some areas of Alaska, *jutta* flies on the tundra above timberline. In Colorado and Wyoming, however, *O. jutta reducta* McDunnough is found in dry lodgepole pine (*Pinus contorta* var. *latifolia* Englem.) forests flying in the deadfall. Occasionally specimens are taken on flowers at the forest edge as reported by Ferris (1970, *J. Lepid. Soc.* 24: 306–307).

An even more striking example of habitat variation occurs in *Speyeria nokomis* (Edwards). In the United States, *nokomis* is associated with very wet areas, either sloughs or moist alpine meadows where the larval foodplant, *Viola* spp., grows in the understory (Ellis 1969, *J. Lepid. Soc.* 23: 62–26; Ferris & Fisher 1971, *J. Lepid. Soc.* 25: 44–52). In Mexico, *S. nokomis coerulescens* (Holland) is found in a completely different habitat. The butterfly flies in Chihuahua and Durango in dry pine woods. During its flight season (late August and September), frequent rains maintain an almost bog-like condition of the pine needle and duff layer on the forest floor. Violets grow in this layer (L. P. Grey and J. R. Mori, pers. comm.). Adult *nokomis* are found in some nearby meadows, but only because of a concentration of thistles and other nectar sources.

Latitude can play a major role in determining where butterflies of a given species are found. Two of many possible examples are: *Papilio i. indra* Reakirt and *Lycaena*

cupreus snowi (Edwards). The former butterfly is normally associated with ridge tops in foothill areas. This is certainly the case in the eastern Sierra Nevada and in Colorado and Wyoming. Occasionally specimens are taken at lower elevations at puddles following a rain shower. My initial experiences with *indra* and other subspecies confirmed that they occupy the barren ridge habitat where certain of the larval foodplants, Umbelliferae, grow. During the summer of 1972, I found that *i. indra* is a moist meadow flier in the Sawtooth Mountains of Idaho. Specimens were taken flying and nectaring in Transition Zone meadows at 7100 ft. The Idaho locality was about two degrees further north in latitude than the most northern point in Wyoming where I have taken *indra*.

Lycaena cupreus snowi is recorded in Colorado only from above timberline (ca. 10,000 ft. and above) where it flies next to the snow fields (Brown et al. 1957, Colorado Butterflies, Denver, Colo.). Just to the north, in Wyoming, the butterfly is generally taken in the Upper Transition and Canadian Zones in open meadows. I have taken a few specimens at timberline in the Wind River Mountains and on the Beartooth Plateau, but most specimens have been taken at much lower elevations. In the Sawtooth Range in Idaho, I have found *snowi* relatively common in open meadows at 7100 ft.

In conclusion, I would make three points. First, different subspecies of a butterfly may be found in widely disparate habitats, in different parts of North America. Second, based upon observations from one locality, one cannot make inferences concerning other regions without a thorough knowledge of all of the environmental variables involved. Third, in some instances, "micro-environments" may be the dominant factor controlling species distributions, as in the Mexican race of *Speyeria nokomis*.

(This note is published with the approval of the Director, Wyoming Agricultural Experiment Station, as Journal Article JA 595.)

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LEPIDOPTERA FEEDING AT PUDDLE-MARGINS, DUNG AND CARRION

I would like to make a few additions to J. A. Downes' paper under this title (1973, J. Lepid. Soc. 27: 88-99). I discussed this question on more than one occasion with Collenette, and he often said that he was of the opinion that the attraction of damp mud lay in the mineral salts in general, and probably in the sodium chloride in particular, contained therein. I have two pieces of evidence that would appear to support this opinion. When collecting at Lech-am-Arlberg in Austria in 1958, it was noticed that, whilst the damp mud surrounding puddles formed in the mountain paths after a storm were highly attractive to butterflies, the damp mud at the side of permanent trickles of water crossing the same paths were always completely deserted. Presumably the mud round the puddles would be heavily impregnated with mineral salts leached out of the surrounding soil, whilst mud beside permanent trickles would have had everything washed out. Again in Africa it is noticeable that the attraction of damp mud increases with the distance from the sea. In the Shimba Hills I have only found *Anthene lasti* Sm. & Kby. (Lycaenidae) at damp mud; the nymphalids that feed at damp mud are the same species that are attracted to fermented fruit baits and, as both sexes are present, the attraction is obviously juices from rotten fruit that has fallen from the trees bordering the path. In the actual coastal forest at Jadini, situated within a mile

from the sea, and in the Arabuku-Sekoke Forest, males of the various *Papilio* and *Graphium* species (Papilionidae) and *Appias sabina* Feld. (Pieridae) occur at damp mud, but nothing else. Both the latter forests are far more sheltered and less windy than the forests of the Shimba Hills. Compare this very meagre list with the number of species recorded in the Kenya Highlands and Western Uganda when motoring through in 1960: Kenya Highlands (Danaiidae 3, Acraeidae 3, Nymphalidae 2, Lycaenidae 11, Pieridae 5, Papilionidae 1); Western Uganda (Danaiidae 5, Acraeidae 0, Nymphalidae 5, Lycaenidae 7, Pieridae 9, Papilionidae 3). (A full list of species will be found in 1962, *Entomologist* 95: 17-18). It is, perhaps, noteworthy that not a single hesperiid was recorded, as this is the family concerned in all the records of butterflies settling on human skin, exuding a drop of fluid from the anus, and then sucking it up through the proboscis.

It is suggested that butterflies in the coastal areas absorb enough salt with their food as larvae, the shore level forests being more sheltered, and so receiving less salt, than the more exposed forests in the Shimba Hills. The air all along the Kenya coast is heavily impregnated with salt, which is deposited as a thin film on windows and which causes heavy corrosion in metal fittings.

I was surprised to read in Downes' paper that horse droppings were found to increase the attractiveness of damp mud and water. In Africa the droppings of herbivorous animals, antelopes, buffalo and elephant for example, hold no attraction whatever, and it is only the droppings of carnivores that are attractive. I am not even certain that the faeces of the Canidae are attractive, as the droppings of my own dogs, which are fed mainly on meat, do not attract the *Charaxes* species that frequent my garden, but I have never come across the droppings of jackals or foxes in the bush.

That there is some difference in the food requirements of male and female butterflies appears to be confirmed by the habits of the Charaxidae, where both sexes are attracted to fermenting fruit and sap but only the males to dung and carrion. Possibly there is some connection with the production of the female-attracting scents secreted by the males. A very specialised case of this connection is the recently discovered necessity for the males of certain Danaiidae to feed on the fermented juices of certain plants of the Boraginaceae before they can develop this scent.

I have one example of male moths feeding at damp mud, a *Semiothisa* sp. (Geometridae) identified by the British Museum (Natural History) as near *fuscataria* Mschl., which was found in considerable numbers at mud puddles in a forest in Uganda.

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LARVAL FOODPLANTS AND PARASITES OF SOME LEPIDOPTERA IN SOUTHEAST ARKANSAS

A great deal of information is available concerning the larval foodplants and parasites of the more important lepidopterous pests in Arkansas. Little such information is available for Lepidoptera species not considered primary insect pests. With greater emphasis on pest management programs in recent years and increasing interest in biological control of pests, it is becoming more important to understand the relationships among animals and plants. In order to elucidate some of these relationships, the following study was conducted on or near the White River National Wildlife Refuge during the summer months of 1969 and 1970.

The White River Refuge, a relatively undisturbed habitat, consists of portions

of Arkansas, Phillips and Monroe counties. The Refuge is 56 miles long, 3 to 6 miles wide, and consists of 113,600 acres of mixed hardwoods. About 75% of the Refuge is flooded in winter and spring by the Mississippi, Arkansas, and White Rivers. Approximately 600 to 1000 acres are annually planted in agricultural crops, a portion of which serves as food for the wildlife. The crops include rice, soybeans, grain sorghum, other small grains and forage grasses.

Lepidopterous larvae were collected on or adjacent to the Refuge and brought to a field laboratory for rearing. Each larva and a portion of the hostplant were placed in a waxed paper cup covered with a clear plastic lid. If the larva was an internal feeder, i.e. stem borer or leaf miner, the hostplant was placed in a vial of water within the cup. Fresh cuttings of the hostplant were added daily to the cups containing externally feeding larvae. The older food was removed only after the larvae had willfully changed to the new food. The cups were checked daily for emergence of adult moths and parasites. Hostplant specimens were collected for identification.

Twenty-six lepidopterous species representing 12 families were reared from 20 species of host plants. Seventeen species of parasites representing 4 families of Hymenoptera and Diptera were reared from the Lepidoptera. The following is a list of the lepidopterous species reared, dates of emergence, localities collected, hostplants and parasites. The dates given are dates of emergence of the moths and parasites.

Acrobasis sp. PHYCITIDAE. 11 August 1970, 4 miles east Ethel. **Host:** *Liquidamber styraciflua* (sweet gum). **Parasites:** *Campoletis* sp., *Exochus* sp., *Trathala tetralophae* (Cush.), ICHNEUMONIDAE; *Phanerotoma tibialis* (Hald.), BRACONIDAE; *Pseudochaeta clurina* Rein., TACHINIDAE.

Anavitrinella pampinaria (Guenée) GEOMETRIDAE. 26 July 1971, 4 miles southeast Ethel. **Host:** *Eupatorium* sp.; 10 July 1971, 8 miles southeast Ethel. **Host:** *Amaranthus hybridus* (pigweed).

Argyrotaenia velutinana (Walker) TORTRICIDAE. 4 July 1971, 5 miles southeast Ethel. **Host:** *Ilex decidua* (deciduous holly).

Asterocampa clyton (Boisduval & LeConte) NYMPHALIDAE. 12 September 1971, 4 miles southeast Ethel. **Host:** *Celtis mississippiensis* (Hackberry). **Parasites:** *Apanteles* sp. BRACONIDAE.

Brachmia melantharella (Busck) GELECHIIDAE. 17 July 1970, 2 miles southeast Ethel. **Host:** *Xanthium pennsylvanicum* (cocklebur).

Characoma nilotica (Rogenh.) NOCTUIDAE. 12 July 1971, 3 miles north St. Charles. **Host:** *Salix* sp. (willow). **Parasites:** *Brachymeria ovata* (Say), *Spilochalcis sanguineiventris* (Cress.) CHALCIDIDAE.

Choristoneura rosaceana (Harris) TORTRICIDAE. 30 June 1971, 5 miles southeast Ethel. **Host:** *Hypericum* sp. (St. John's wort). 30 June 1971, 5 miles southeast Ethel. **Host:** *Rubus* sp. (blackberry).

Conchylodes platinalis (Guenée) PYRAUSTIDAE. 27 July 1971, 5 miles northwest Snow Lake. **Host:** *Ambrosia trifida* (giant ragweed).

Delta ramulosa (Guenée) NOCTUIDAE. 2 August 1971, 4 miles southeast Ethel. **Host:** *Hypericum* sp. (St. John's wort).

Desmia funeralis (Huebner) PYRAUSTIDAE. 13 July 1971, 5 miles southeast Ethel. **Host:** *Vitis* sp. (wild grape). **Parasites:** *Eucordyligaster septentrionalis* (Tns.) TACHINIDAE.

Eumaroza malachitana (Zeller) OLETHREUTIDAE. 19-23 August 1971, 3 miles southeast Ethel. **Host:** *Diospyros virginiana* (persimmon). **Parasites:** *Agathis annulipes* (Cress.) BRACONIDAE.

Fascista cercerisella (Chambers) GELECHIIDAE. 25 July 1971, 4 miles southeast Ethel. **Host:** *Cercis canadensis* (redbud).

Filatima serotinella (Busck) GELECHIIDAE. 23 July 1971, 2 miles southeast Ethel. **Host:** *Prunus* sp. (wild cherry).

Heterocampa subrotata (Harvey) NOTODONTIDAE. 3 July 1971, 5 miles south-east Ethel. **Host:** *Celtis mississippiensis* (hackberry).

Hymenia perspectalia (Huebner) PYRAUSTIDAE. 28 August 1971, 2 miles south-east Ethel. **Host:** *Amaranthus hybridus* (pigweed).

Hysorophia hormos (Huebner) NOCTUIDAE. 19 August 1970, 5 miles southeast Ethel. **Host:** *Diospyros virginiana* (persimmon). **Parasites:** *Meteorus* sp. BRACONIDAE.

Loxostege sp. PYRAUSTIDAE. 27, 28 August 1971, 2 miles southeast Ethel. **Host:** *Amaranthus hybridus* (pigweed). **Parasites:** *Cremnops haematodes* (Brulle) BRACONIDAE; *Nemorilla pyste* (Walker) TACHINIDAE.

Mineola indigenella (Zeller) PHYCITIDAE. 1-3 August 1971, 4 miles southeast Ethel. **Host:** *Crataegus viridis*. **Parasites:** *Eusisyropa boarmiae* (Coq.), *Eusisyropa virillis* (Aldrich & Webber) TACHINIDAE.

Olene leucophaea (Abbot & Smith) LIPARIDAE. 2 October 1970, 6 miles south St. Charles. **Host:** *Liquidamber styraciflua* (sweet gum).

Phaecasiophora niveiguttana (Grote) OLETHREUTIDAE. 1 August 1971, 2 miles southeast Ethel. **Host:** *Sassafras* sp. (sassafras). **Parasites:** *Macrocentrus ancy-livorus* Roh. BRACONIDAE.

Polychrosis sp. OLETHREUTIDAE. 4 August 1971, 2 miles north St. Charles. **Host:** *Amaranthus hybridus* (pigweed). **Parasites:** *Agathis annulipes* (Cress.) BRACONIDAE.

Psilocorsis caryae Clarke OECOPHORIDAE. 23 August 1970, 3 miles east Ethel. **Host:** *Carya* sp. (hickory).

Psilocorsis quercicella (Clemens) OECOPHORIDAE. 4 August 1971, 4 miles southeast Ethel. **Host:** *Quercus* sp. (oak). **Parasites:** *Temelucha grapholithae* (Cush.) ICHNEUMONIDAE.

Scythris trivinctella (Zeller) SCYTHRIDAE. 2 October 1970, 3 miles southeast Ethel. **Host:** *Amaranthus hybridus* (pigweed). **Parasites:** *Nemorilla pyste* (Walker) TACHINIDAE.

Stegasta bosqueella (Chambers) GELECHIIDAE. 18-24 July 1971, 5 miles southeast Ethel. **Host:** *Cassia fasciculata*.

Xenolechia "Telphusa" sp. group GELECHIIDAE. 2 August 1969, 2 miles south St. Charles. **Host:** *Salix* sp. (willow).

Thanks are due Mr. Raymond McMasters for his cooperation in allowing use of the White River National Wildlife Refuge; Drs. Ed Smith and Patricia Coons for plant determinations; Drs. Paul Marsh, R. W. Carlson, C. W. Sabrosky, and B. D. Burks for determination of parasites; and Drs. R. W. Hodges and Ed Todd for determination of Lepidoptera. This article is published with the approval of the Director, Arkansas Agricultural Experiment Station.

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A NOTE ON FREEZE-DRYING CATERpillARS

At the request of Dr. Richard B. Dominick this small amount of information is offered to anyone interested in freeze-drying caterpillars without purchasing any materials whatsoever. In the summer of 1971 several saturniid caterpillars (mainly *Hyalophora* species and hybrids) were frozen alive with the original intention of keeping a small larval collection in the freezer permanently. On adding more specimens to the box in the spring of 1973, the 1971 ones were observed to be very light in weight. They were taken out, and no changes have been observed for

months thereafter. Some wrinkling of the skin had occurred in the freezer, but the colors were excellent, including tubercles. The fact that the kitchen freezer used was self-defrosting apparently answers the question of where the moisture went. It seems that had a well-ventilated box been used, the same results could have been achieved in several months instead of two years.

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FREEZE-DRYING AND VACUUM DEHYDRATION: INSTRUMENTATION

Some time ago I reported on the process of freeze-drying and vacuum dehydration for the preservation of immatures (Dominick 1972, *J. Lepid. Soc.* 26: 69-79). Since then, experience has led to some modification of procedure and equipment. These recommendations form the substance of this article. It is assumed that the reader has before him the previous report (of which a few reprints are still available), for this article will proceed point by point on that basis.

The pump oil should be changed regularly, otherwise the efficiency of the pump may be seriously impaired. An oil change is recommended after every 20 hrs. of operation, so a disconnect coupling (an "O" type ring) is desirable. Such disconnect couplings will also be found useful for anyone desiring to construct a mobile field unit.

The inside diameter of the tubing is of no great consequence in the system described. However, $\frac{3}{8}$ in. tubing is recommended over $\frac{1}{4}$ in., for two minor reasons: first, a slightly more efficient pull-down time will result, and second, the larger diameter is a bit easier for the amateur to flare or solder.

Next, it is advantageous to lower the temperature of the freezer below the -7°C (20°F) previously recommended, since opening the freezer door can quite easily raise the temperature to above freezing. By removing the taped end of the thermostat from the ice-making compartment and gently bending it out of the way into the rear of the larger compartment, the temperature of the whole unit may be lowered to between -12 to -15°C (10 to 5°F), while the ice-making compartment goes down to about -24°C (-15°F). The resulting increase in drying time is not sufficient to be of practical concern. This lower temperature, in fact, is theoretically more suitable for the preservation of integrity of the cells.

Previously the suggestion was made that Duco or similar cement would help preserve the integrity of the permanent joints. The suggestion is erroneous, for proper flaring alone guarantees the adequacy of sealing. If the flare (or soldering) is not properly made, no amount of posthumous treatment will help.

As for killing the animal, I have largely abandoned the method of very quick deep freezing, which often agitates the larva so much that presentation of a lifelike attitude becomes difficult. It also influences the cellular integrity by destructive crystal formation. Slow freezing in the main compartment in general seems best. In case an undesirable attitude prevails, correction should be made as soon as possible, before the larva is frozen through. Try to avoid thawing a frozen specimen, for this has undesirable effects on some of the color pigments. Try to manipulate the larva when it is just cold enough to be dormant, but before cellular freezing. Frank R. Hedges, Houston, Texas, suggests that contact with the ambient air after any degree of freezing might change some of the chemically activated color pigments, and my own experience tends to bear this out. In such a case the larva may be put straight away into a cold desiccator and left to freeze to death, applying vacuum only when thoroughly frozen. One may have to sacrifice a lifelike posture in favor of coloration. More experimentation is needed. Other methods of killing are

satisfactory, for example, cyanide or boiling water. With regard to ethyl acetate and other organic solvents, one must consider the possibility of solubilizing effects on certain plastics used in the apparatus. Properly processed larvae tend in general to retain their color well, with the exception, in my limited experience, of some greens and a few reds.

Concerning the equipment, first there are the desiccators. I now use exclusively the Nalgene vacuum chamber with neoprene gasket. It is made of transparent polycarbonate and may be ordered with gasket and plastic top. It stands about 25 cm high, and the recommended freezer holds two with ease. A further blessing is that they need not (in fact *must* not) be greased. If one is careful to keep the contact surfaces free of dust, dirt and ice crystals, these desiccators will hold the vacuum very well. A further advantage is that the plastic will not break and splinter to the dangerous proportion of a glass vessel in case of an implosion.

As for pumps, valves and manometers as well as all the fittings, I have recently been in touch with a company whose catalogue offers such equipment of commendable quality at good prices. For example, I have been told by two refrigeration experts that the pump I now use is rated at a vacuum of 0.1 micron, but will not pull down in practice to better than 25 microns/Hg, which is still adequate for the purpose. To understand the need for a high vacuum efficiency in the process, one must realize that 1 micron equals approximately 1/25,400 in. Hg, and remember that any pressure above 1–200 microns in the system renders the vacuum operation meaningless.

Some companies also supply high vacuum line valves, copper tubing, "O" type disconnect fittings, and for the permanent joints, a method of soldering requiring only the heat from a small propane torch. Such a method of fixing the permanent joints, of course, eliminates the task of flaring, a job extremely difficult to accomplish successfully where there are numerous joints in close proximity to one another.

Practical suggestions as to specific companies have been published recently in the *News*.

My warm thanks to Dr. Hermann A. Flaschka, who has taken time to edit and correct the original manuscript with humor as well as detail, and to Dr. Theodore D. Sargent, who has performed further needed surgery.

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THE DISTRIBUTION AND LARVAL FOODPLANT RELATIONSHIPS OF *SATURNIA WALTERORUM* (SATURNIIDAE)

Saturnia walterorum Hogue & Johnson is perhaps the rarest saturniid in the United States, occurring locally in southern California. There are relatively few field data available for this moth. Fewer than 30 specimens have been collected and most specimens in collections have been reared from eggs secured from captured females. Sala & Hogue (1958, *Lepid. News* 12: 17–25) described the life history of *S. walterorum* reared under laboratory conditions. It is the purpose of this paper to present new information on flight period, distribution, and larval host records. A future publication will examine the taxonomic relationship between *S. walterorum* and *S. mendocino* Behrens.

Saturnia walterorum is known only from 4 coastal counties in southern California: San Luis Obispo, Los Angeles, Orange, and San Diego. One specimen in the Los Angeles County Museum of Natural History is labeled "Cajon Valley." This label may refer either to El Cajon Valley in San Diego County or Cajon Pass in San Bernardino County. Suitable habitats seem to exist in at least 4 additional

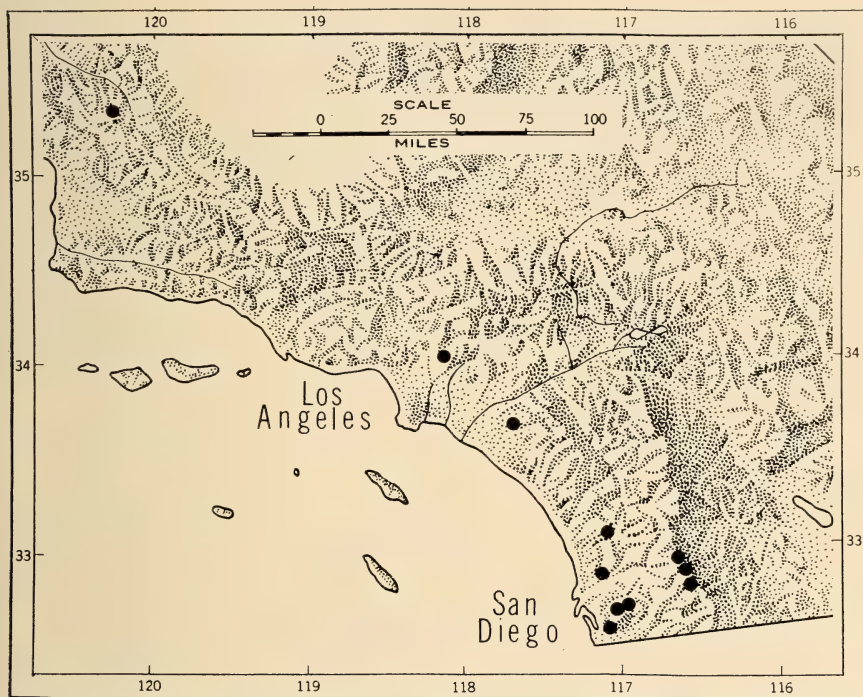


Fig. 1. Known distribution of *Saturnia walterorum* in southern California.

counties in southern California and portions of Baja California, but no available records indicate that it has been sighted or collected other than in the previously mentioned counties. The moth has been collected at elevations varying from 100 to 5500 ft. on both the coastal and high desert slopes of the mountains in southern California (Fig. 1). The flight period at lower elevations begins in late February and extends into mid-April, while at higher elevations specimens have been collected between April and mid-May. Individuals are on the wing only on warm sunny days from 0930 to 1530 hrs.

The larval hostplant of *S. walterorum* has been in question for some time. Field observations indicate that larvae, pupae, and oviposition have occurred only on plants of the families Anacardaceae and Ericaceae. It is interesting to note that plants of the family Ericaceae serve as the host for *S. mendocino*, a species which occurs to the north of, and is thought to be allopatric to, *S. walterorum*.

Two species of Anacardaceae are known to serve as natural larval hosts; these are *Rhus laurina* Nuttall and *R. integrifolia* Bentham & Hooker. Both species of *Rhus* inhabit dry chaparral slopes below 3000 ft. On two occasions females were observed ovipositing on *R. integrifolia* by the author, and empty cocoons have been found in association with this shrub (Sala & Hogue, op. cit.). Larvae have also been collected on *R. laurina* in San Diego by R. Hatch (pers. comm.).

At higher elevations it appears that members of the family Ericaceae serve as larval hosts. One larva has been collected on an unidentified species of *Arctostaphylos* in the San Gabriel Mountains (Sala & Hogue, op. cit.). Adults have been observed in association with various species of *Arctostaphylos* in the Santa

Monica, and San Gabriel Mountains by C. Henne (pers. comm.) and in the Laguna Mountains by R. Breedlove (pers. comm.).

The larvae of *S. walterorum* exhibit two distinct color phases; one green, and the other reddish-orange. The bark of *Arctostaphylos* and areas of new growth on both species of *Rhus* are characteristically red in color. Therefore, each color phase of the larvae may blend into different portions of its environment. This adaptation may make them less conspicuous to natural enemies while on the hostplant. Larvae of both color phases emerged from the ova of one female in a ratio of 1:1.

The cocoon, which is brown and coarsely constructed, appears similar to the dried inflorescences of *Rhus*. This similarity may be advantageous, for reared larvae usually pupate at the terminal ends of branches among dried flowers or at the base of the plant, thus concealing the pupation site.

I would like to thank the following individuals for allowing me to examine their records and specimens: Christopher Henne of Pearblossom; Fred Thorne of El Cajon; Dave and Jean Roldness of San Diego; James Tilden of San Jose; Eric Walters of Anaheim; and Charles Hogue and Julian Donahue of the Los Angeles County Museum of Natural History.

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AN UNUSUALLY LONG PUPAL STAGE OF *BATTUS POLYDAMAS POLYDAMAS* L. (PAPILIONIDAE)

For a number of years my sons and I have been breeding butterflies found in El Salvador. Among them we have reared from egg to adult, several times, groups of *Battus polydamas polydamas* L. The full process has taken an average of 40 days, pupation alone from ten to eighteen days. According to Young (1971, Ann. Entomol. Soc. Amer. 60: 595-599), in Costa Rica the total development for this species averages 41.32 days, ranging from 36 to 46 days, with pupation ranging from 14 to 16 days.

On 14 June 1972 we saw a female lay seven eggs, which were collected and put in a transparent plastic bag. On the 20th, the eggs hatched. The larvae were fed with fresh leaves of the foodplant, *Aristolochia anguicida* L., until pupation, which occurred between 8 and 10 July. Only five larvae had survived out of the seven. On 17 July, the first adult, a male, emerged, that is 9 days after pupation, which is a little shorter than usual. The next adult, another male, emerged on 19 July, 11 days after pupation, being this time closer to average.

With the remaining three individuals, pupation time was completely unexpected. The third adult, a male again, emerged on 27 October; the fourth, another male, on 7 December; and the fifth, a female, on 25 January 1973! The pupal stage in these three cases was 110, 150 and 199 days respectively. All of these adults were absolutely normal and healthy.

We emphasize the fact that this species is gregarious during the early stages, and that the seven larvae were kept in the same bag, and therefore under the same conditions of food, light and temperature. When pupation occurred, the pupae were placed in the same pupation box, and again they were exposed to the same environmental conditions until the first two adults emerged. At that time one of the pupae was given to Mr. Steve R. Steinhauser, who lives in the neighboring town of Santa Tecla, some 13 km. from San Salvador, at a slightly higher altitude. This pupa was the one that lasted 199 days. The other two were in the same box at all times.

We have found a report of aestivation in one species of Saturniidae, *Rothschildia lebeaui* ? aroma Schaus (Quezada 1967, Rev. Biol. Trop. 19: 211-240), whose pupa spends the six months of the dry season waiting for the first rains to fall. The dry season in this country starts in November and ends in April. The wet season starts in May and ends in October. Consequently the case we are reporting happened during part of the wet season and part of the dry. It is true that the weather was somewhat chaotic during 1972, there being a long spell of dry weather during July (20 days) and August (15 days), and then copious rain during November and the beginning of December.

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AN INVASION OF EASTERN COLORADO BY *VANESSA CARDUI* (NYMPHALIDAE)

My notes for the Spring of 1973 show that *cardui* first came to my attention at Fountain Valley School (11 miles SE of Colorado Springs, Colo.) on 19 April. That day had started with near freezing temperatures and a light snow flurry. At noon I saw two *cardui* flutter over the lawn. A week or ten days of warmish weather followed with early morning temperatures as high as 44° F. Around 1430 on 28 April I was driving south from Denver on State Highway 83. About five miles north of Parker I met swarms of *cardui* drifting toward the northeast. I estimated about 100/150 passing directly in front of me each mile. This continued almost all of the way home, about 70 miles. There was a break going over the Platte-Arkansas Divide.

Examination of the insect, as flying at Fountain Valley, showed the specimens to be badly worn to tattered and the ground color to be quite pale. The concentration on the lawns may have reached 500 per acre. These butterflies were feeding at dandelion flowers and later apple blossoms. The numbers held reasonably steady until 11 May when another wave arrived. These specimens were considerably larger, and much fresher and darker in color. A careful estimate made around 1530 that afternoon placed the numbers on the lawns (30 acres) at about 1,000 per acre and on the prairie (2,000 acres sampled) about 150 per acre. These concentrations remained relatively constant until the weekend of 19-20 May and the two succeeding days when the weather was rainy and cold. By 23 May there were very few *cardui* around, just about the normal situation.

On 18 May driving south on I-25 to New Mexico, the numbers of *cardui* flying across the highway were high enough to materially reduce the efficiency of the automobile's radiator. It was necessary to stop after about 100 miles to clean the radiator and scrape the squashed remains from the windshield. This situation continued through the 18th and 19th.

There are very few thistles in the vicinity of Fountain Valley School. It will be interesting to see if we have an abnormally large crop of *cardui* in early summer. If we do, it will be important to discover the alternate foodplant here. The several large patches of thistle known to me along highway 83 in Douglas County will be watched with interest.

Postscript: Larvae used *Helianthella* and two species of *Lupinus* after the few thistles were stripped to the ground.

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AMPHION NESSUS (SPHINGIDAE) ATTRACTED TO FEMALE
ANISOTA VIRGINIENSIS PELLUCIDA (CITHERONIIDAE)

On 24 May 1973 near McClellanville, South Carolina, an *Anisota virginiensis pellucida* (J. E. Smith) female emerged from a brood reared on *Quercus nigra* the previous August. She was put outdoors to call in males during the day. Other matters pressing, I was able to spend only short periods at the cage, during which time I saw several males of the same species and also captured three males of *Amphion nessus* (Cramer) that homed in directly to the cage and buzzed about trying to get in. The data follow, all times being Eastern Standard time:

Anisota virginiensis ♂♂: 24 May, 1045; 25 May, 1107 and 1130.

Amphion nessus ♂♂: 26 May, 1415, 1416 and 1430.

The most obvious possibility would seem to be a similarity in the chemical configuration of the sex pheromones of the two species, distantly related as they are. (A previous paper (Dominick, R. B. & C. R. Edwards 1971, J. Lepid. Soc. 25: 84-85) reported on the flight pattern of male *Anisota virginiensis*.)

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BOOK REVIEWS

THE EVOLUTION OF MELANISM, The Study of a Recurring Necessity, With Special Reference to Industrial Melanism in the Lepidoptera, by Bernard Kettlewell. 1973. Clarendon Press, Oxford. xxiv + 424 p., illus. + plates. Price: \$33.00 (U.S.).

This eagerly anticipated work provides a valuable compilation of the data and conclusions of Kettlewell and his associates on the phenomenon of melanism in the Lepidoptera. Although broad in scope and rich in detail, the book possesses some shortcomings which will be discussed following a résumé.

The work is divided into 19 chapters (in seven major sections), followed by three appendices, a list of recorders, and a bibliography with better than 600 entries (including references through 1971). There are 38 pages of plates (35 halftone, 3 color), 14 text figures, and some 40 tables.

The book begins with a general consideration of melanism, its nature and functions (3 chapters). This introduction stresses Kettlewell's major theme that melanism has been a recurring necessity in the evolutionary histories of diverse organisms. This section is followed by one on melanism specifically in the Lepidoptera (3 chapters), which includes classifications of both adult and larval melanisms, as well as a general treatment of the phenomenon of industrial melanism, and a review of the world-wide distribution of that phenomenon.

Attention is then focused on the now-famous *Biston betularia* (3 chapters). The mark-release-recapture selection experiments in Birmingham and Dorset (1953-1955) are recounted, and the history and spread of the melanic forms in Great Britain are documented. Special reference is made to the frequency surveys (1952-1970) which Kettlewell has compiled from the records of nearly 170 observers, and these data are detailed in an 11-page appendix. Kettlewell then turns to consider non-industrial melanisms (3 chapters), in particular his own extensive work, including mark-release-recapture experiments, on *Amathes glareosa* in Shet-

land. This section is followed by a treatment of recessive melanism (2 chapters) in which recent work on *Lasiocampa quercus* is described. A variety of melanisms are then described as miscellaneous (4 chapters). This last section includes examples of aposematic, sex-linked, and environmental melanism, as well as a short consideration of melanism in butterflies. The main body of the text is concluded with a regrettably short synthesis (1 chapter, 6 p.), and there follow appendices on breeding techniques (4 p.) and melanism in British moths (38 p.).

To turn now to criticisms of the book, I would first point out certain matters which may provide some annoyance to readers. The most important of these concerns the arrangement and numbering of the "plates." These plates (actually halftone figures) are numbered in the order of their citation within the text, but are arranged into bundles of halftone pages in an oftentimes different sequence. Thus, one finds for example, plates 3.1 and 7.2 on the same halftone page. I sought plate 5.17a for a full five minutes after coming to its citation in Chapter 5. (The situation is rendered more confusing in my copy of the book by an error involving reversal of the plates belonging between pages 56-57 and pages 120-121.) A lesser annoyance is created by the absence of titles in some five percent of the bibliographic references. Finally, I note that at least one investigator whose work is critically discussed has been omitted from the author index.

A few more substantive matters are of greater concern. The quality of some of the black-and-white photographs is quite poor (e.g. plates 10.4 and 14.6), and one wishes that better specimens could have been selected for certain illustrations (e.g. plates 10.5 and 13.2). With regard to the literature, a few recent papers have been overlooked, in particular those of Klots (1964-1968, J. N. Y. Entomol. Soc.) and others dealing with melanism in North American species.

This book is a highly personal document, and as such must reflect the personality of its author. This reflection is generally engaging, and some occasional lapses of objectivity, particularly with regard to certain theoretical areas of biology, serve to enliven the sometimes tedious text. There are, however, certain dangers in this approach, and sometimes a question of fairness arises (e.g. with regard to ornithologists, p. 121). More serious, of course, would be any unfairness to specific individuals. On occasion, to this reviewer's mind, the data and conclusions of certain workers are disputed, re-interpreted, or rejected without an adequate airing.

Elaboration of the following example may strike some as improper, but I risk that judgment in order to call attention to what I regard as a serious misrepresentation. In the section of the book dealing with experiments on the background preferences of moths (p. 68-72), Kettlewell cites four papers of this reviewer, and details strong criticisms of the experimental techniques therein reported. He goes on to assert that in these studies "the main issue is missed," i.e. whether the forms of polymorphic species differ in background preferences. In response, I must contend that the criticisms of techniques would only be applicable had those techniques failed to yield readily interpretable results, and would point out that two polymorphic species (with a melanic form in each case) were tested for background preferences in the papers that are cited. (Kettlewell rather curiously overlooked another paper (1969, *Nature*, Lond. 222: 585-586) in which the background preferences of the typical and melanic forms of *Phigalia titea* were tested.)

This book is primarily, and properly, a vehicle for the elaboration of Kettlewell's own ideas on all aspects of melanism, but one might have hoped for a fuller treatment in certain areas. For example, little treatment is accorded the possibility that various factors associated with industrialization, *other* than darkening of the environment, might act, either directly on the insects, or indirectly through effects on predators or the vegetation, to provide an advantage to melanic individuals. Another idea which receives scant attention, and for which there is considerable experimental evidence, is the possibility that the melanic forms of cryptic species

might differ genetically from their typical counterparts in terms of background resting preferences.

In summary, while this book may fall somewhat short of expectation with regard to scholarship and synthesis, it is on the whole an ambitious and admirable project. Herein are compiled the results of two decades of substantial and varied investigations by the author and his associates on the phenomenon of melanism in the British Isles. As a single source of these many results, this book will have a permanent value.

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BUTTERFLIES OF THE WORLD, by H. L. Lewis. 1973. Harrap Books, London; and Follett, Chicago. xvi + 312 p.; 208 pls. Price: about \$30.00 (U.S.).

No book could begin to live up to the pretentious title of this one, though in some respects *Butterflies of the World* makes a good attempt. There are recognizable figures of many (definitely *not* even most) of the world's species, and the figures alone would make the volume worth far more than its purchase price *if* all of the species were correctly identified.

Regrettably such is not the case. I have the feeling that Brig. Lewis prepared the text and the legends for the figures based on one idea of how the insects on each plate would be numbered, but that someone else did the final numbering. Those plates with even columns and rows of figures do not show transpositions, only those with irregularly placed specimens. Nevertheless, the presence of such easily avoided errors suggests careless proofreading and is inexcusable. A partial listing of the plates affected by transpositions of numbers includes plates 19, 60, 63, 64 and 118; there are others. Such errors greatly diminish the accuracy and usefulness of the book.

Errors of fact are even less excusable. *Anartia amalthea* (L.), figured on Plate 13 and listed from "N. and C. America," is in fact a South American butterfly that has not been recorded from either North or Central America, though Seitz lists it without documentation from Central America. *Troides aeacus* (C. & R. Felder) from the Indo-Australian region is figured on Plate 24 as *Eurytides xanticles* (Bates) from the American tropics: even utilization of a rudimentary knowledge of Lepidoptera could have prevented this mistake. The genus *Anetia* has been variously considered a danaid (correctly) or simply a nymphalid, but not a heliconiid as figured on Plate 43; and the danaid genus *Ituna* is included on Plate 44 as a heliconiid. *Tellervo*, the only Indo-Australian ithomiid, is shown on Plate 156 as a danaid.

Lewis states (p. xii), "... the names given in the book are those commonly in use, and to be found in the latest works of scholarship. . . ." Unfortunately, the "latest work of scholarship" published in the Western Hemisphere seems to be Klots' 1951 *Field Guide*! At the same time Forster's Bolivian satyrid work is partially, but not critically, accepted, resulting in *Altopedaliodes tena* (Hewitson) being figured as that on Plate 54 and as *Pedaliodes tena* (Hewitson) on Plate 63. Some nomenclatorial questions that were thought to be solved have been rescrambled, such as the distinction between *Euphyes* and *Atrytone* (Plate 21) and the replacement of the preoccupied *Plestia* by *Zestusa* (Plate 22).

There is a small Corrigenda sheet accompanying our copy of this book: unfortunately it should be much larger! The number of inadvertent synonyms created is very large (e.g., *Mitoura spinetorum* for *M. spinetorum* on Plate 20), and a full errata sheet should be forthcoming to rectify these errors. Since this book is

being merchandised by many booksellers throughout the English-speaking world it will be bought by many budding lepidopterists, ones who will never see a review that points up some of the errors in it. For the future accuracy of records provided by these people, an errata sheet (really a pamphlet) is not only desirable, but a must.

This book is fairly good and accurate for the Old World and quite poor and out-of-date for the New. Perhaps one expects too much from a book that purports to be what this one does, but it simply is not a good book. I personally feel that Lewis was fighting a deadline and sacrificed final accuracy for a publication date. We would all be happier had he not! Nevertheless, *if* one takes the determinations with the proverbial "grain of salt," the figures make the book useful, for there are the best available representations of many poorly-known species contained within it. Further, one can get a general idea of what to expect in an area, even if he dare not rely on the names.

LEE D. MILLER, *Allyn Museum of Entomology, 3701 Bay Shore Road, Sarasota, Florida 33580.*

HEWITSON ON BUTTERFLIES, 1867-1877, with a Preface by Dr. L. G. Higgins. 1972. E. W. Classey Ltd., Hampton, Middlesex, England, iv + 242 p. (including cover pages). Price: \$12.50 (U.S.). Distributed exclusively in the United States by Entomological Reprint Specialists, P. O. Box 77224, Dockweiler Station, Los Angeles, California 90007.

This volume contains reprints of four privately published works by William Chapman Hewitson: "Descriptions of one hundred new species of Hesperidae" (1867-1868), "Descriptions of some new species of Lycaenidae" (1868), "Equatorial Lepidoptera collected by Mr. Buckley" (1869-1877) and "Bolivian butterflies collected by Mr. Buckley" (1874). In these remarkable papers Hewitson described ten new genera and no fewer than 403 new species of butterflies, all of which he intended to figure in either his *Illustrations of . . . Exotic Butterflies* (1852-1872) or *Illustrations of Diurnal Lepidoptera* (1863-1878). Regrettably Hewitson could figure only about half of the species described in these four pamphlet sets.

L. G. Higgins' Preface gives a brief, but interesting account of Hewitson's life and the histories of these important works; the works themselves give an insight into Hewitson. Hewitson was a wealthy enough man to afford the publication of his own papers and a proud one, as demonstrated by his comments justifying the publication of "Descriptions of some new species of Lycaenidae":

"Were I aware that any entomologist was engaged in a monograph of any particular group of butterflies, I should consider that I merely performed an act of common courtesy in avoiding said group until he had done with it. An entomologist, knowing that I am and have been for some time engaged in a monograph of the Lycaenidae, has, fortunately for me, given me notice that he is about to describe all those species in his possession. It is therefore in self-defence alone that I have been driven, greatly against my wish, to publish the following descriptions of species . . ."

Most systematists can identify with Hewitson in this complaint!

While it was Hewitson's fondest wish that he could figure all of the species described by him, he was unable to complete the task. Inasmuch as the types are preserved in the British Museum (Natural History), though some have not been identified with certainty, this volume could have been made an exceedingly valuable contribution by the inclusion of even black-and-white photographs of the

relevant Hewitson types. Perhaps these photographs, along with a more modern treatment of the names, can be the basis of a future companion volume to the present one.

The specialist can ill-afford to be without this book, unless he is fortunate enough to have access to the original papers. The amateur, however, can gain little from it because of the absence of illustrative material. The insights into Hewitson alone may make the book interesting to the general reader, especially if he is a history buff.

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AN AMATEUR'S GUIDE TO THE STUDY OF THE GENITALIA OF LEPIDOPTERA. 1972. Published by the Amateur Entomologist's Society, Feltham, Middlesex, England (A. E. S. Leaflet No. 34). 16 p., 15 figs. Price: not known. Available through the Publications Agent, L. Christie, 137 Gleneldon Road, Streatham, London, S. W. 16, England.

This little work is a fine introduction to the dissection and study of the genitalia of Lepidoptera, written clearly and concisely and well illustrated by line drawings of actual genitalia and the procedures for dissecting them. Simple step-by-step directions for the dissection of these structures make the study of genitalia something for everyone, not a deep, mysterious subject restricted to the "experts."

The functions of the genitalic structures are discussed so that they have a biological, as well as taxonomic, significance for the amateur. The nomenclature of the parts follows Tuxen's *Taxonomists' Glossary of the Genitalia in Insects* (1956), the only text available which attempts homologies between genitalic structures in the various orders.

The mounting medium for the genitalia discussed is Euparal which is not in vogue on this side of the Atlantic, most slides being prepared here in Canadian balsam or synthetic equivalents. The only real difference in technique involved is dehydration of the genitalia in 95% ethanol, then xylene, and final mounting in the balsam-type medium.

The Amateur Entomologist's Society is to be congratulated on preparing a very handy and informative little booklet. I wish I had an idea of the cost (I am certain it is nominal), but this information can be obtained from the Publications Agent, Mr. Christie. It would be worth doing so for anyone who wishes to become familiar with these important structures.

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JOURNAL

of the

LEPIDOPTERISTS' SOCIETY

Published quarterly by THE LEPIDOPTERISTS' SOCIETY

Publié par LA SOCIÉTÉ DES LÉPIDOPTÉRISTES

Herausgegeben von DER GESELLSCHAFT DER LEPIDOPTEROLOGEN

Publicado por LA SOCIEDAD DE LOS LEPIDOPTERISTAS



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by CYRIL F. DOS PASSOS

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JOURNAL OF THE LEPIDOPTERISTS' SOCIETY

Volume 28

1974

Number 3

PRESIDENTIAL ADDRESS—1973 THE NATIONAL COLLECTION OF LEPIDOPTERA

J. F. GATES CLARKE

National Museum of Natural History, Smithsonian Institution,
Washington, D.C. 20560

James Smithson, an Englishman of noble birth, the natural offspring of the Duke of Northumberland and Elizabeth Keate Macie, a lineal descendant of Henry VII, bequeathed his estate to the United States Government "to found at Washington, under the name of the Smithsonian Institution, an establishment for the increase and diffusion of knowledge among men." Receipt of the bequest in 1838 precipitated a lengthy debate in Congress on whether the Government should, or indeed, could legally accept the funds and accompanying trust. In the Act of 1846, establishing the Smithsonian Institution, provision for a museum was made, and the name "United States National Museum" came into use in the year 1859. In 1884 appropriations to the Smithsonian for the U.S. National Museum were authorized and an annual report to the Congress by its Director was required. Today, the Museum's component parts are the National Museum of Natural History and the National Museum of History and Technology. It is the former in which we are interested here.

This brings us to the National Entomological Collections. The collections of all groups of insects consist of over 22,000,000 specimens. Of these approximately 3,500,000 are Lepidoptera.

The National Collection of Insects is now over 93 years old having been started in 1881 with the transfer of 50,000 specimens to the U.S. National Museum from the U.S. Department of Agriculture. In 1886, C. V. Riley (1843-1895), then Chief Entomologist with the U.S. Department

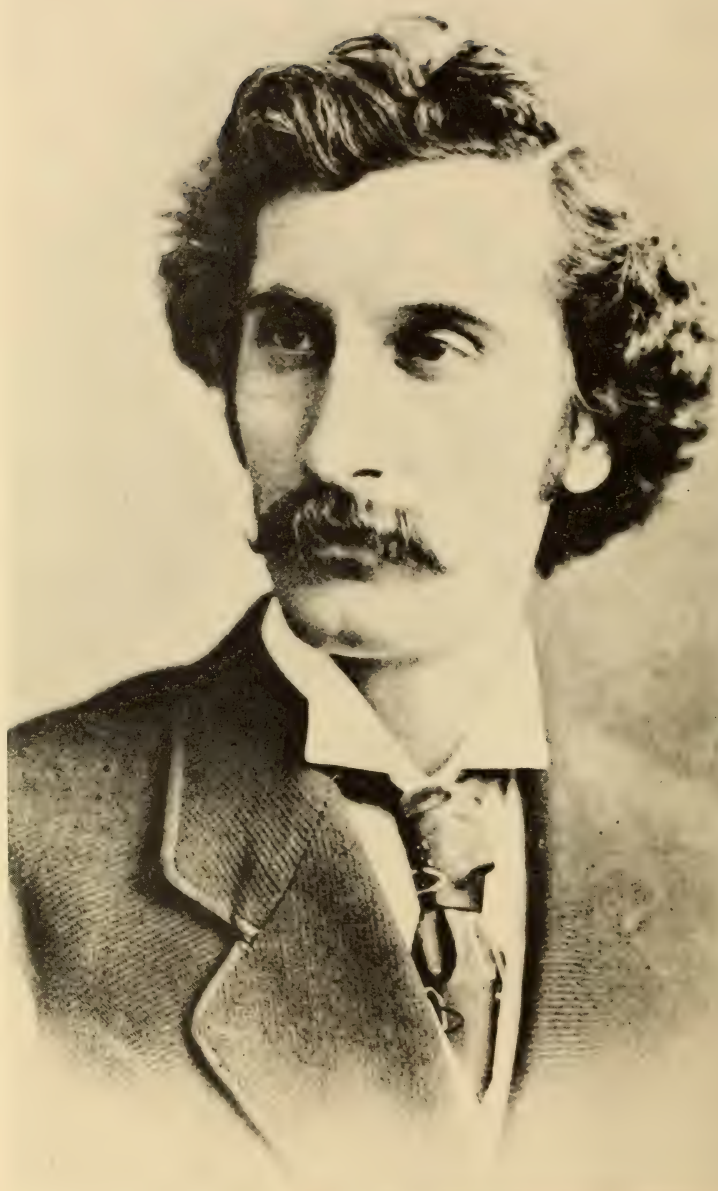


Fig. 1. C. V. Riley, 1843-1895

of Agriculture and honorary curator of entomology at the United States National Museum (appointed in 1882), donated 150,000 specimens of insects to the museum. In neither of the above cases was the number of Lepidoptera noted, indeed, it was not even certain that there were any Lepidoptera in these collections, but "C. V. Riley collection" labels are now occasionally found on specimens of Lepidoptera. Shortly before this time it is said that Townend Glover (1812-1883) also made a contribution to the National Museum, but there are no records in the Smithsonian to prove this claim. Since the earliest times the U.S. Department of Agriculture's entomological organizations and its entomologists have been closely linked with the National Museum and, indeed, the Department of Agriculture's contributions to the National Collection have been great and many.

There was no paid entomologist on the Smithsonian's staff until 1885 when John B. Smith, a lepidopterist, was appointed curator. From 1900 to 1940 the Smithsonian had one staff entomologist. This has now increased to 12, four of whom are lepidopterists. The U.S. Department of Agriculture had 16 specialists in 1930 and 29 in 1974. Of these, four are lepidopterists.

Five men, William Schaus, August Busck, Carl Heinrich, H. G. Dyar and William Barnes (the latter not a member of the museum staff) were primarily responsible for the early development of the National Collection of Lepidoptera.

August Busck (1870-1944)

August Busck was born in Randers, Denmark, 18 February 1870 and in 1893 he came to the Columbian Exposition in Chicago. In March 1896 he was appointed assistant in the Division of Entomology, U.S.D.A., becoming shortly thereafter a specialist in Microlepidoptera. He investigated the mosquito and Lepidoptera faunas of the West Indies in 1905 under the auspices of the Carnegie Institution and made a similar investigation of the mosquito and Lepidoptera faunas of the Canal Zone for the Panama Canal Commission in 1907. Parts of the results of these two expeditions were reported in the Howard, Dyar, Knab monograph of *The Mosquitoes of North and Central America and the West Indies*. Most of the Lepidoptera collected by Busck were reported by Dyar and himself, but some of Busck's material is still being used by today's workers.

Busck was one of the first to use consistently genitalic characters, the most important structures ever to be used in the classification of the various categories of Microlepidoptera.

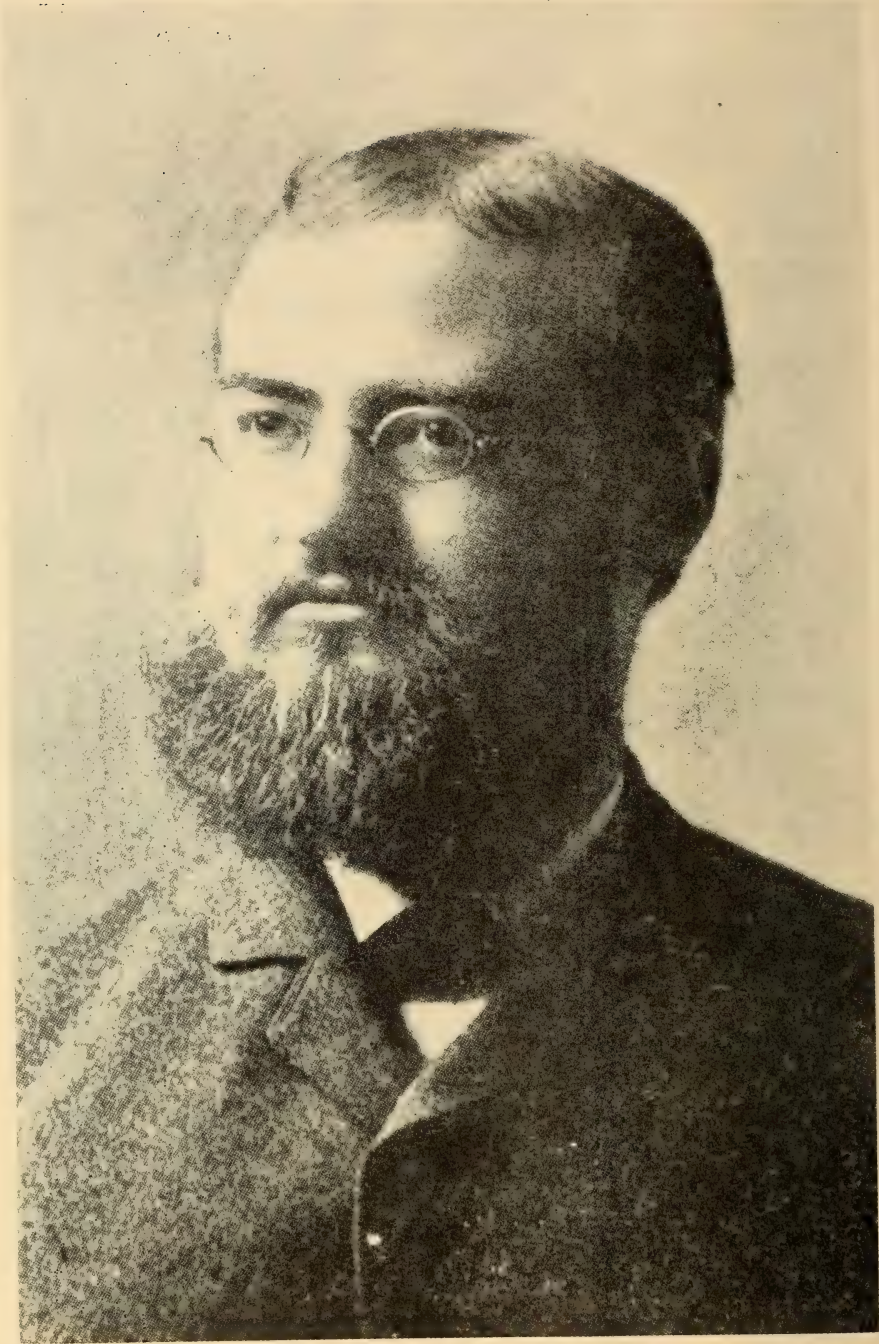


Fig. 2. John B. Smith, 1858-1912



Fig. 3. August Busck, 1870-1944

Throughout his career Busck was intimately associated with the USNM and its collection of Microlepidoptera is the second most extensive and important in the world, and for this eminence Busck must be given chief credit.

Harrison Gray Dyar (1866–1929)

Harrison Dyar was born in New York City and was educated at the Massachusetts Institute of Technology, Columbia University and in the field. He came to the U.S. National Museum in 1897 but was on the payroll of the U.S.D.A.

He was an extremely versatile man. He had a good eye for species, could comprehend major groups of insects and had the ability to study intensively the biology and early stages of one or another group. He excelled in all these fields and was able to make a synthesis of them. His publications include a larger number of full and accurate larval descriptions than the work of any other American entomologist. On the basis of his knowledge of adults, larvae and eggs his work may perhaps be considered the basis of our modern classification of moths.

His greatest work, however, in which he did the taxonomy, was the monumental work *The Mosquitoes of North and Central America and the West Indies* published in four volumes (1912–1917) by the Carnegie Institution. He is also the discoverer and promulgator of what has become known as “Dyar’s Law”—that the widths of the head of a larva in its successive stages follow a regular geometrical progression.

There was another entomological law that emanated from the National Museum known as “Schwarz’s law.” This refers to the accidental occurrence of an insect on a plant and thus the misinterpretation of its host and reminds us that “a bug must have some place to sit.”

Wilhelm Carl Paul Gottlieb Heinrich (1880–1955)

Carl Heinrich was born in Newark, New York, 7 April 1880 and has been described as a poet, writer, student of music, history literature and philosophy. He intended to study music under Edward McDowell but before the opportunity came McDowell died. He came to Washington in 1902 but did not begin working with the U.S. Department of Agriculture until 1913 and retired his services in 1949.

He published 87 papers and books, many of them editorial in nature. His two largest works were the *Revision of the family Olethreutidae* in two parts (1923–1926) and *American moths of the subfamily Phycitinae* (1956). His publications were not confined to entomological subjects.

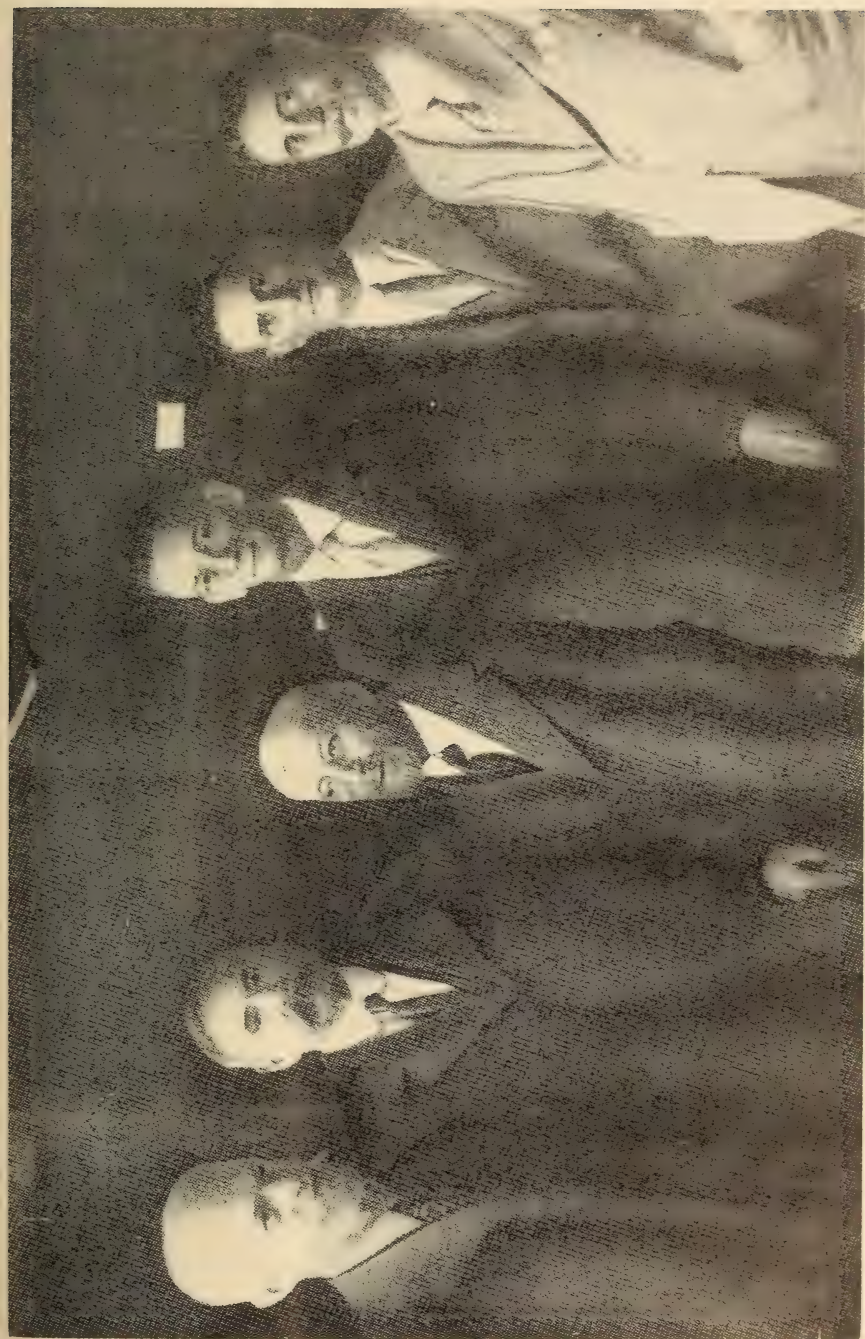


Fig. 4. Left to right: Harrison C. Dyar, William Schaus, L. O. Howard, Carl Heinrich, August Busek, Francis Noyes

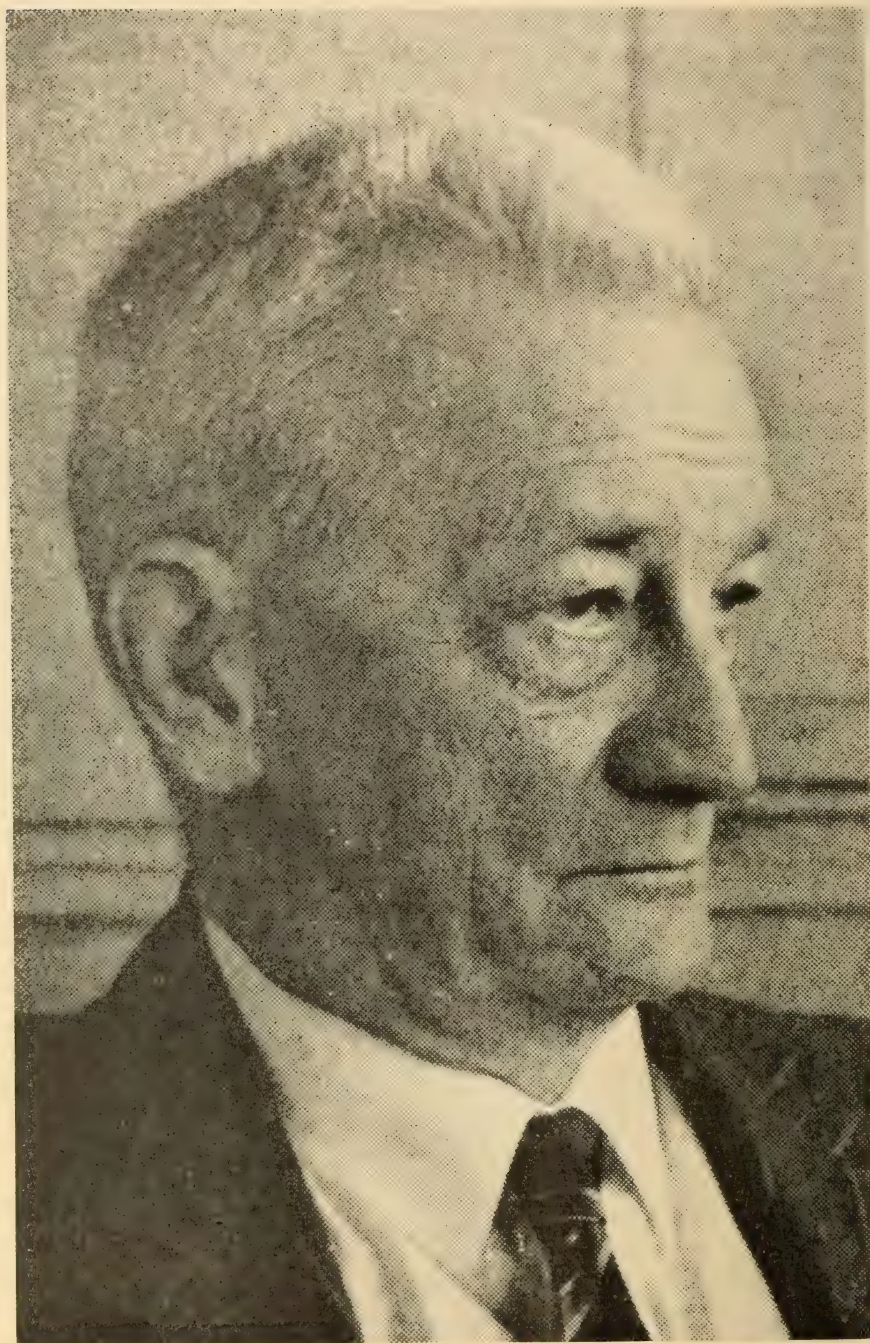


Fig. 5. Carl Heinrich, 1880-1955

In 1901 he published a book of poems *Moods and Moments* and in 1929 his controversial, satirical *The Orphan of Eternity or the Katabasis of Lord Lucifer Satan*. In retirement he wrote 105 articles on subjects of public interest published in the News and Courier of Charleston, South Carolina.

William Schaus (1858–1942)

William Schaus was born in New York City 11 January 1858, the son of a well known art collector and dealer. He was schooled largely in Europe and his principal training was in music, art and languages; but as a young man he came under the influence of Henry Edwards and found his real vocation, in spite of paternal opposition.

Schaus made his first important collecting trip to Mexico in 1883 and subsequently made frequent and extended trips, with his companion Jack Barnes, to Mexico, Costa Rica, Guatemala, Panama, Cuba, Jamaica, Dominica, St. Kitts, the Guianas, Colombia and Brazil and collected over 200,000 Lepidoptera. He was one of the great contributors to, and dedicated workers in, the Lepidoptera collection. Schaus sums up his attitude to the National Collection in a letter from Costa Rica dated 15 March 1909, to Richard Rathbun, then Assistant Secretary of the Smithsonian, in charge of the National Museum, "I . . . announce to you the gift of my butterflies and Sphingidae to the Museum, as they were not included in the large collection of moths I gave the Museum three years ago—I am glad to be able to do so—I am still hard at work and securing many new and rare species, so there is no danger of the Smithsonian losing its foremost place as possessor of the finest collection of Tropical American Lepidoptera."

Schaus came to the National Museum in 1895. By 1906 he was back in Mexico. An accession of 7 June 1906 records "Large collection of Lepidoptera." Schaus' letter accompanying the gift states "The box contained . . . 22 parcels of Lepidoptera." Other accessions merely list "1 box Lepidoptera in papers (1907) Costa Rica, or "29½-cartons of unmounted insects, Costa Rica." Other accessions record material from Argentina, Guatemala, Bolivia, Ceylon, New Guinea, Ecuador and Brazil.

From 1919 until his retirement in 1938, Schaus was on the staff of the U.S. Department of Agriculture and in 1921 was made honorary assistant curator of insects of the U.S. National Museum. During his lifetime he published 122 papers in which he described more than 5,000 species.

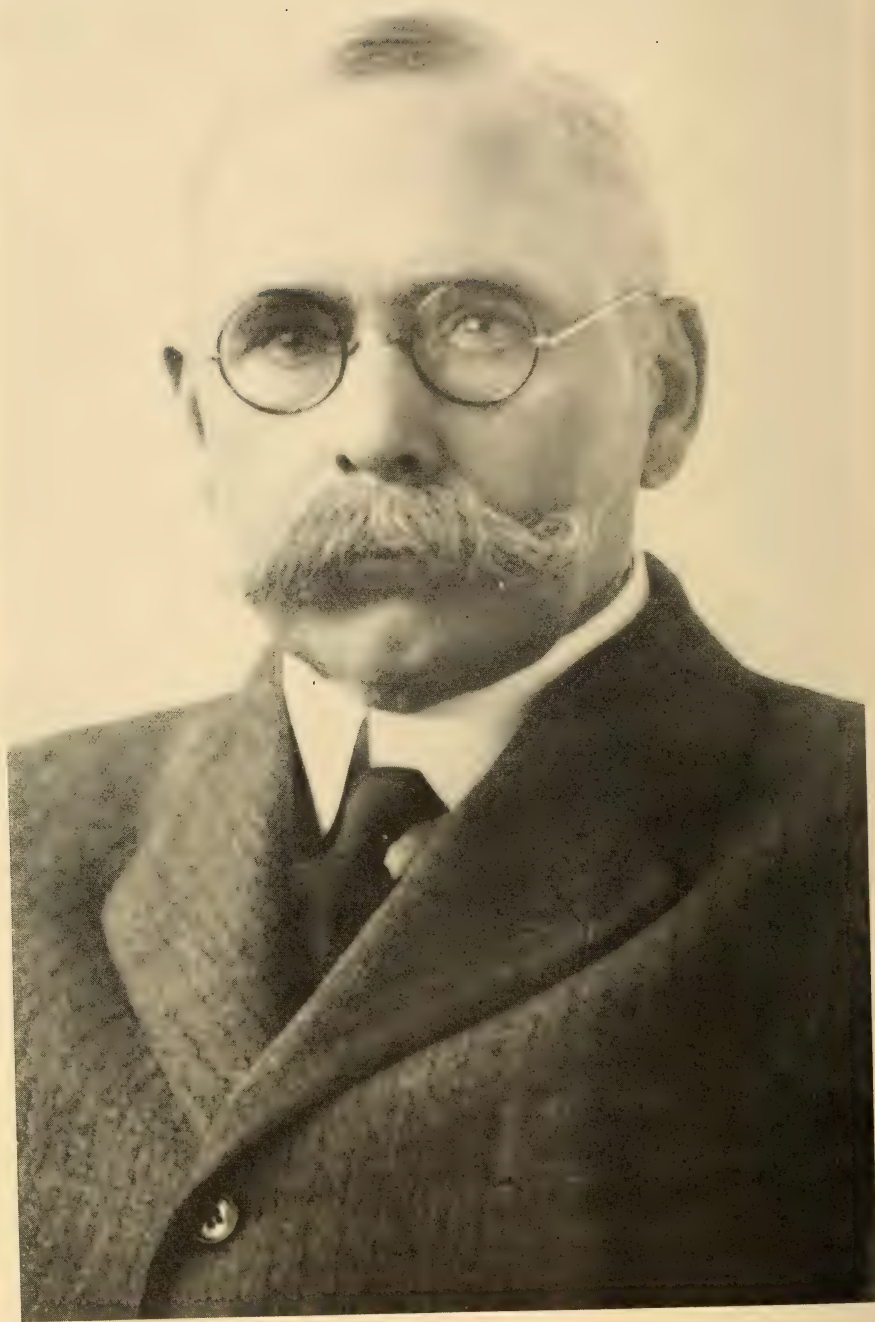


Fig. 6. William Schaus, 1858-1942

William Barnes (1860-1930)

William Barnes was born in Decatur, Illinois, and except for his medical training at Harvard, post graduate medical study in Germany and some travelling, spent all his life there. He brought together the greatest, finest and most complete and most accurately determined collection of North American Lepidoptera in the world. If Dr. Barnes had done nothing but assemble this collection he would have done a great work, but he did much more. His copiously illustrated *Contributions to the natural history of the North American Lepidoptera*, which occurs in 5 volumes, embodies the researches of himself and his collaborators, and consists of extensive descriptive and revisionary papers.

Some details about the Barnes collection follow:

As early as 1921 a move was afoot to obtain for the National Museum the William Barnes collection. J. M. Aldrich, Associate Curator of insects, stated in a letter of 31 October 1921 to Dr. Stejneger, Head Curator of Zoology: "The value of the collection is so great that we can make no offer from the current revenues of the National Museum or the Smithsonian, that would not be absurd and pitiful. The case will require special action by Congress, I should think." Dr. Barnes was seeking \$200,000. What he had actually proposed doing was to give the collection to the Decatur and Macon County Hospital to be sold by them for added revenue. In 1922, Representative Moore of Illinois presented a bill (H.R. 10597) asking for enactment of authorization for the Secretary of the Smithsonian to purchase the Barnes collection for \$310,000 (including shipping). Negotiations continued until Dr. Barnes' death in 1930. The late Secretary Abbott, of the Smithsonian, on June 13, 1930 sent a memo to Dr. Wetmore, then Director, U.S. National Museum, stating "The executors desired to give the National Museum first opportunity to obtain the collection for \$50,000. (Barnes is reputed to have spent \$400,000 on the collection.) The collection was finally purchased through a congressional appropriation with a rider on an agriculture deficiency bill. Carl Heinrich and August Busck prepared the collection for shipment and the collection was accessioned February 16, 1931.

By the time I arrived at the National Museum both Barnes (who was not on the staff) and Dyar were dead, but Busck, Heinrich and Schaus were still active.

For many years Busck and Heinrich performed like twins. They dressed alike, both used a cane, and about the only way they could

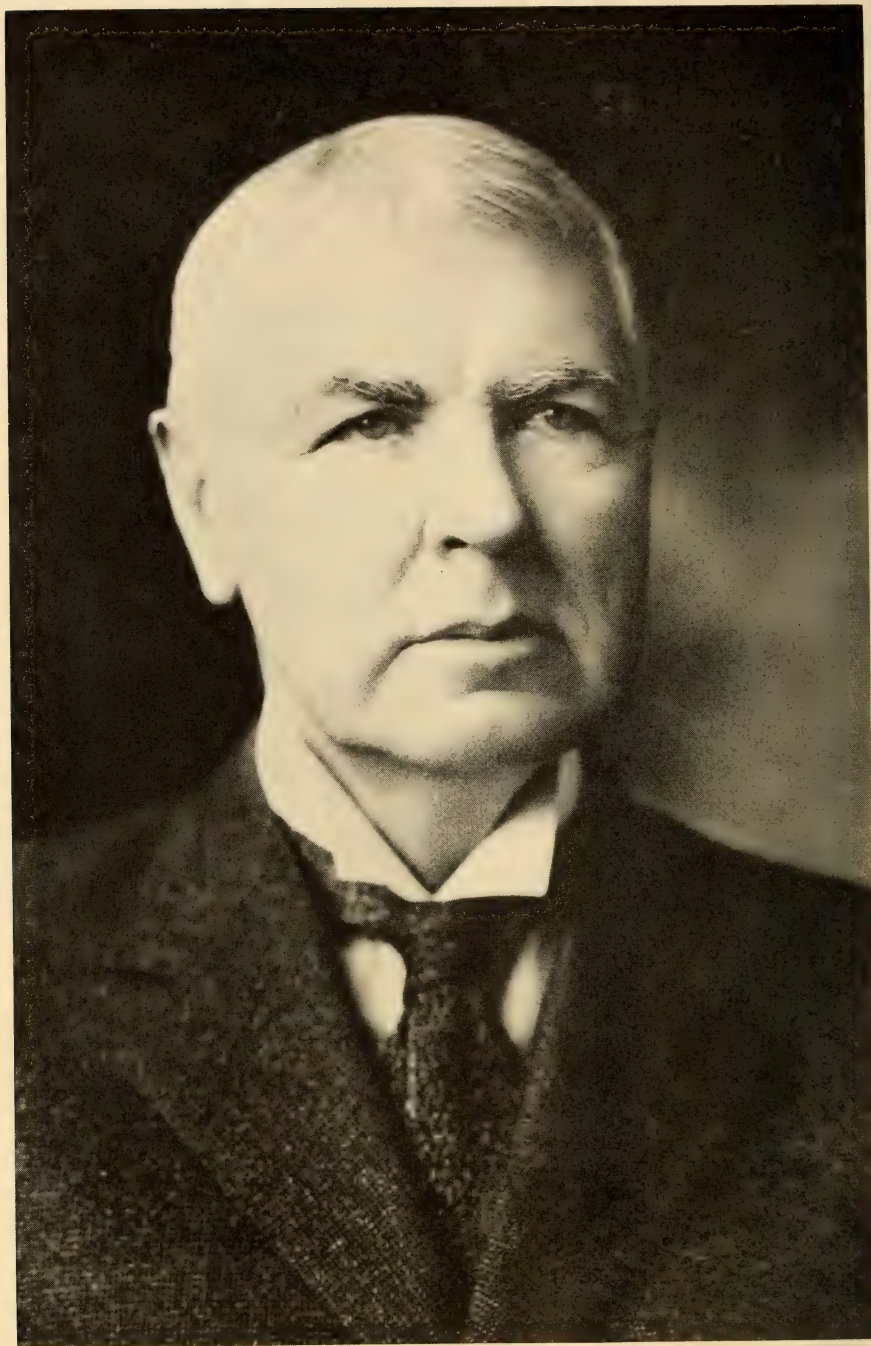


Fig. 7. William Barnes, 1860-1930

be distinguished at a glance was by the fact that Heinrich wore a monocle. This close relationship went on for years but finally something happened, to which I was not privy, and the friendship ended. After that, even up to the time of Busck's retirement in 1940 this feud lasted. They were civil enough to each other at the office, but after official hours there was no communication between them at all. When Busck's end was near, early in 1944, Heinrich relented and decided to go and visit, for the last time, this old friend. Busck was on his death bed, but said to Heinrich, "Vell, Carl, let's go downstairs and have a drink, I don't vant to die sober!" Busck died shortly thereafter.

For many years it was customary to accumulate reprints in the Division of Mammals, where we were allowed to examine and select what we wanted for our files. The practice was to indicate a bid, usually 5¢, and initial the amount offered. If someone wanted the reprint more than the first bidder he increased the offer to 10¢, and so on until bidding was closed. During one of these "auctions" a copy of Busck's *A Revision of the American Moths of the Family Gelechiidae* . . . 1903, appeared. I did not have this paper so I offered the usual 5¢. Busck's pride was hurt; he was angry. He burst into my office and roared, "I have just seen your bid on my gelechiid paper. I have bid 25¢ and if you vant the paper you will have to pay 30¢!". I did.

Heinrich is reputed to have started each day with a martini! He smoked cigars and cigarettes incessantly and used snuff. The smokers in the museum were provided with spittoons for their cigar and cigarette ashes and butts up until the 1950's. The spittoons were also used to throw waste from dissections. One day, inadvertently, when Heinrich threw away some waste from a dissection an aedeagus from a type went with it. Obviously, that was a loss that could not be accepted so Heinrich, with an aide, spent the day going through cigar butts, cigarette tobacco and waste, spoonful by spoonful, looking for the aedeagus. They found it!

Schaus was a bachelor. On one of his visits to England he employed a valet, Jack Barnes, who became his lifelong companion. Early in their association Schaus, in admiration for his friend, bought him a quantity of stocks. In the crash of 1929 Schaus lost much but after the crash Barnes' stocks appreciated and the valet became wealthier than the master. When Schaus died he left Barnes a considerable amount of money, plus a valuable stamp collection so Barnes was fixed for life.

Schaus enjoyed a wide correspondence throughout much of the world and wrote his correspondents in English, German, French and Spanish, as appropriate.



Fig. 8. A drawer containing *Zephyrus* species.

It is no wonder that Schaus described 5000 species. He took his work home with him! Nearly every night he would take home with him a small box containing half-a-dozen specimens, each representing a different species. In the morning he would return with each species described and each specimen labeled "type." Over the years there were some slight deviations from this practice but one can generally depend on the specimens labeled "type" as the ones he carried home.

Schaus had many friends among the wealthy and it was through them that he, singlehandedly, raised the money for the purchase of the Dognin collection. Schaus told me that the purchase price was over-subscribed and that he had had to return checks of \$5,000 and \$10,000.

In preparation for his retirement Schaus was cleaning out all personal belongings, among them many reprints of his papers. I discovered that he was discarding them and decided to retrieve them for future distribution. Schaus discovered this. One morning, not even stopping to remove his coat and hat, he stormed into my office and accused me of saving the reprints for later sale. From then on he tore each reprint in two before throwing it into the wastebasket!

The museum collection of Lepidoptera is housed in approximately 30,000 drawers, nearly 3,000 of which are devoted to Microlepidoptera. In recent years the unit tray system has been employed although the whole collection has not yet been converted to that type of housing. For large species, most Sphingidae, Saturniidae, Papilionidae, etc., whole drawers are still used, with no division being made in the drawers by trays.

Some of the more important accessions that are included in the national collection are as follows:

Alfieri, Anastase. 1966. (purchase). This material consists of Egyptian Heterocera, including many types.

Baker, Charles Fuller. 1928 (gift). No breakdown of the more than 300,000 specimens in this collection is given but it contains perhaps the largest number of Philippine Lepidoptera yet assembled by one person plus bountiful material from Malaya.

Barnes, William. 1931 (purchase). The accession shows a record of 473,500 but the actual count was 473,293 specimens including 1950 holotypes. This collection consists mainly of North American material. In the Barnes collection is incorporated material from the Oberthür, Taylor, Kearfott, Polling, Lacy, Field, Hill, Longley, Spalding and Merrick collections.



Fig. 9. A drawer of Microlepidoptera showing tray system.



Fig. 10. Douglas Ferguson (USDA) examining specimens in one of the lanes of the range.

- Blackmore, E. H. 1937-39 (gift). Though small, this collection is all from British Columbia and consists of 6950 specimens.
- Box, Harold. 1963 (gift). This collection consists of 5000 specimens, entirely of the important sugar cane feeding genus *Diatraea*.
- The Brighton Museum, Brighton, England. 1949 (gift). There are 15,000 Microlepidoptera in this material. Nearly all species from England are represented.
- The Brooklyn Museum. 1929 (gift). This material consists of 37,000 miscellaneous insects, and although the collection is comprised largely of Lepidoptera, the exact number of specimens of this order was never recorded. Contains types of Neumogen, Hulst and others.
- Clarke, J. F. Gates. 1937 (gift). From the Pacific Northwest. The original gift consisted of over 10,000 specimens. All Clarke types (over 300), except one, are in the national collection.
- Dognin, Paul. 1925 (purchase). This collection consists of 82,000 specimens among which are 3,000 Dognin types and over 300 Thierry-Mieg types. The collection was purchased through public subscription and was then presented to the museum.
- Dyar, H. G. 1903 et seq. (gift). The first contribution recorded from Dyar consisted of 20,320 specimens from British Columbia. In 1917 he added another 17,000 North American specimens and subsequently numerous smaller gifts.
- Engelhardt, George P., 1941-1943 (gift). Contains over 9,000 Aegeriidae. Its great value lies in the fact that nearly all specimens are reared and that larvae are associated with the adults.
- Ferguson, Douglas. 1970 et seq. (gift). There are 48,000 specimens from the Northeastern United States and eastern Canada, predominantly from Nova Scotia; also from Newfoundland.
- Fernald, C. H. 1924-25 (purchase). This is a type collection of Microlepidoptera containing not only Fernald's tortricid types, but types of Fitch's Pterophoridae and types from Fish. The collection also contains cotypes of Walsingham, Hulst, Packard and Grote.
- Field, W. D. 1947 (gift). This gift of 5,000 specimens is composed of Japanese and European Rhopalocera. Field contributed numerous other smaller gifts of North American Lepidoptera.
- Graham, David C. 1918-1948 (gift). Over the many years indicated, the Rev. David C. Graham sent thousands of Chinese Lepidoptera to the National Museum. These were never counted, but were recorded as so many packages.

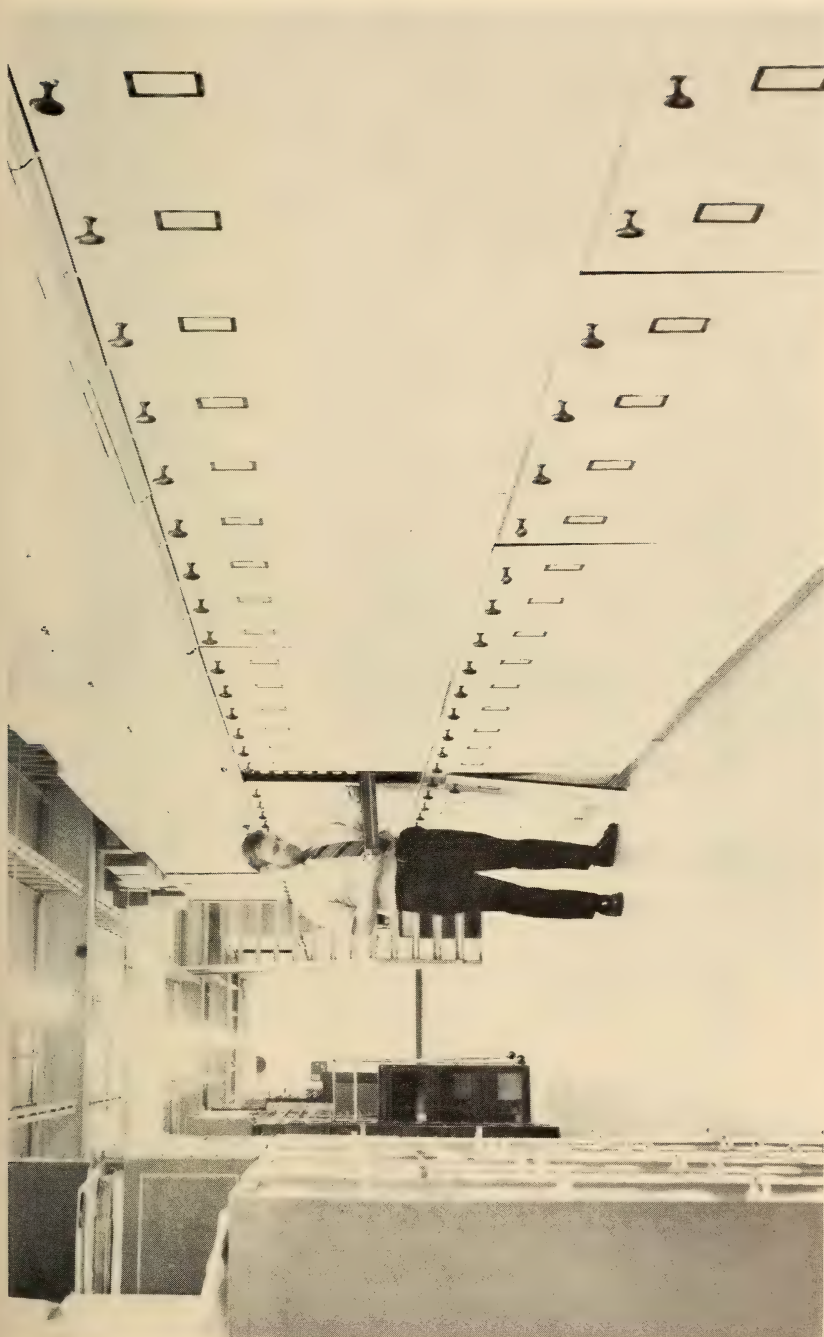


Fig. 11. Donald Davis on Microlepidoptera range.



Fig. 12. Mrs. Sally Adams (USDA), technician, making dissections.

- Hayward, H. C. 1949 (gift). The Hayward collection of English Tortricidae was obtained by the British Museum (Natural History) and presented to the USNM.
- Hodges, Ronald W. 1962 (gift). Consists of 25,000 specimens primarily of North American Microlepidoptera largely from Arizona, New York and Florida.
- Hopfinger, J. C. 1962 (purchase). This collection is worldwide in scope but the preponderance is from Washington State.
- Jones, Frank Morton. 1950-56 (gift). Of the 8,460 insects given to the National Collection the most important segment consisted of 4,400 specimens of Psychidae (bag worms). Most of the species included are from the Americas.
- Issiki, Syûti. 1972 (purchase). The Issiki collection constitutes the most complete assemblage of Japanese and Formosan Microlepidoptera ever brought together and contains about 95 per cent of the known Japanese species. There are 78 holotypes and more than 200 secondary types in this material.
- Meadows, Don. 1950 (purchase). There are nearly 9,000 specimens primarily from the Channel Islands, off the coast of California, in this accession.
- McAlpine, W. S. 1972 (gift). This collection consists of more than 12,000 specimens, predominantly of the butterfly genus *Calephelis*, but also it is strong in miscellaneous Michigan Lepidoptera. Most of McAlpine's types are included.
- McElvare, Rowland R. 1967 (gift). In this accession there are over 4,200 specimens of the sub-family *Heliothinae* (Noctuidae) from North America. Types of McElvare's species are in the National Collection.
- Nawa, U. 1903 (gift). Japanese Lepidoptera exhibited at the St. Louis World Fair constitute this gift.
- Philpott, A. 1928 (gift). Donated in this gift is a nearly complete collection of New Zealand Microlepidoptera.
- Rawson, George W. 1962-1972 (gift). The more than 9,000 specimens are mostly North American, predominantly from Michigan and Florida.
- Schaus, Wm. 1901 et seq. (gift). Altogether, as correctly as the records can be interpreted, Schaus donated most of approximately 200,000 specimens he collected from the Neotropical Region. But many of his contributions were merely recorded as "3 crates" or "2 crates," and the numerous specimens were never counted. About 5,000 of his types are included.



Fig. 13. Technicians Cary Hevel and William Rowe, Collections Management Services Unit.

Schönborn, Wm. E. and Theresa F. 1925 (gift). This collection consists of material from the eastern United States and Europe.

Shoemaker, Ernest. 1957 (gift). This accession records 60,338 specimens of insects but is not broken down by order. The collection contains mostly Neotropical and Nearctic species and is rich in the genus *Morpho*.

Smyth, J. Adger. 1947 (gift). Mr. J. Adger Smyth's father, Dr. Ellison A. Smyth, made this collection of more than 16,000 Lepidoptera, including two types. It is worldwide in coverage. Subsequently (1970) J. Adger Smyth donated an additional 1,174 specimens from the Americas and Africa.

Vallins, F. T. 1971 (purchase). This entire collection of 22,000 specimens of Lycaenidae is of Palaearctic origin. The collector endeavored to assemble series of species from throughout their ranges, thus showing all variations known.

In addition to the collections obtained from gifts, purchases, and transfers from other governmental agencies, much accrues to the national collection through field work by a very active staff. In recent years there have been many expeditions to many parts of the world which have produced Lepidoptera. Extensive field work has been conducted in many parts of North America, nearly every country in Central and South America, and the West Indies, Australia, Africa and Borneo. On the island of Dominica (BWI) alone a survey of the terrestrial arthropods continued over a period of three years, with a change of team and emphasis every three months. A continuing program, now in its fifth year, is being conducted in Sri Lanka (formerly Ceylon). Much material has been acquired from the islands of the Western and South Pacific, including Micronesia, Society Islands, Tubuäis, Marquesas and the Philippines.

Copies and original photographs for this article have been made by Mr. Victor Krantz, staff photographer, Smithsonian Institution.

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TECHNIQUE FOR SPECIFIC DETERMINATIONS OF DEAD PUPAE OF *EUPITHECIA* (GEOMETRIDAE)

Pupae of *Eupithecia* die even when reared under what seem to be optimal conditions. In many cases considerable time is spent on descriptions of larvae with the expectation of rearing adults to enable one to determine the species. When the specimen dies in the pupal stage this time may be lost unless one can determine the species from the pupa. Sometimes pupal development is such that adult features can be seen within the pupal case.

Method. To determine if the genitalia have developed sufficiently, sever the pupa between the fourth and fifth abdominal segments. If the internal organs have not developed sufficiently the abdomen will appear empty and it is of little use to proceed further. If such is the case, place the two halves of the pupal case in a gelatin capsule of suitable size and replace in the collection for future study. A shrivelled abdomen may, however, still be satisfactory for further work. About three-quarters of the specimens examined have had the genitalia developed sufficiently for one to make specific determinations. If the specimen seems developed enough, the entire severed abdomen is immersed in a 10 percent solution of potassium hydroxide for approximately 16-20 hrs. Do not attempt to forcibly remove the abdomen from the pupal case before immersion in KOH solution, unless it is already loose, otherwise both may be damaged. After removal from the caustic, place in a solution of 30 percent alcohol and the abdomen will separate very easily from the pupal case without damage. The empty portion of the pupal case should be placed out to dry and later put in a gelatin capsule along with the remainder of the pupal case. The cremaster and other important diagnostic characters can still be used for study. Process the abdomen as suggested by Hardwick (1950, Can. Entomol. 83: 231-235). Extreme care should be taken, however, during the dissection as the material is usually much more fragile than in a fully mature adult. One should also keep in mind that the pupal case may contain a parasite which has died before emerging. These are often quite large and can be mistaken for a moth before dissection.

This technique has proved useful for the determination of species in several other genera of Geometridae besides *Eupithecia*. Among these are the genera *Deilinia* Hbn., *Rheumaptera* Hbn., *Hydriomena* Hbn., *Drepanulatrix* Gump., *Semiothisa* Hbn., and *Itame* Hbn. This technique could very well prove useful in other families of Lepidoptera as well.

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THE MICROTymbALS OF SOME ARCTIIDAE

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Acoustic communication between moths and bats has provided biologists with several intriguing examples of predator-prey interactions. Moths of some families, notably the Arctiidae, Ctenuchidae, Geometridae, and Noctuidae, possess tympanic organs capable of detecting the echolocating cries of bats (Eggers, 1928; Schaller & Timm, 1950; Haskell & Belton, 1956; Roeder & Treat, 1957). When presented with a source of ultrasonic pulses (cries of an echolocating bat or facsimiles thereof), restrained noctuid moths show changes in wingbeat and the same moths while flying free in the field perform evasive maneuvers (Treat, 1955; Roeder, 1962, 1967 a, b).

When confronted with ultrasonic pulses, some arctiid and ctenuchid moths produce ultrasonic sounds usually consisting of a repeating sequence of brief, high-pitched, rapid clicks. These clicks are produced by a row of minute ridges or corrugations (= microtymbals or the 'striate band' of Forbes & Franclemont [1957]) in the cuticle of the metathoracic episternite (Fig. 1). The basalar muscle inserts on the concave inner surface of the episternite, and its contraction cycle causes the microtymbals to buckle in sequence; each 'buckle' producing a click considerably less than one millisecond in duration and containing ultrasonic frequencies (Blest et al., 1963; Blest, 1964). The contraction cycle of the basalar muscle determines the duration of the click cycle, and the number and form of the microtymbals on the episternite affects the number and acoustic nature of the clicks in each cycle.

Some arctiids and ctenuchids are not only noisy, but often distasteful (Beebe & Kenedy, 1957; Rothschild, 1961; Blest, 1964; Rothschild & Alpin, 1971). Some arctiids evert cervical glands when threatened (eg. *Utethesia ornatrix bella* (L.); Eisner, 1970, Fig. 6a), and this may be accompanied by noise (eg. *Arctia caja* (L.); Rothschild, 1965). Potential predators of these species may learn to associate the noise with an unpalatable taste and thus use the noise as a signal to leave the moths alone.

Captive *Myotis lucifugus* (LeConte) (Chiroptera: Vespertilionidae) avoided noisy *Haploa clymene* (Brown), *Halysidota tessellaris* (Abbot

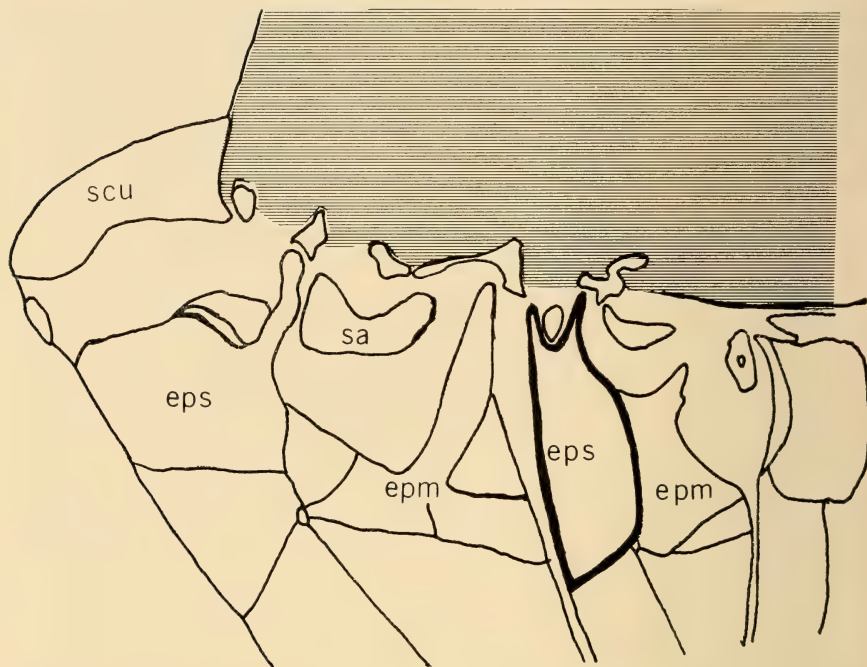
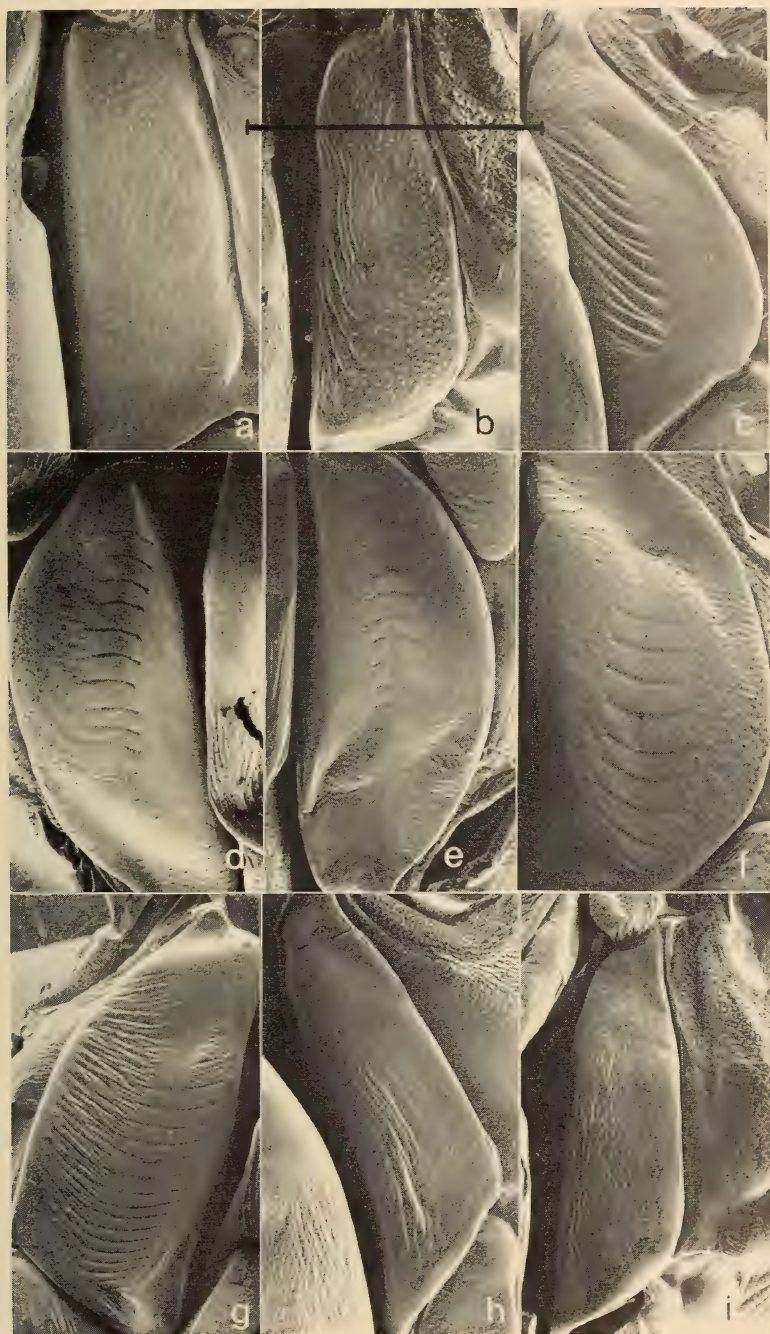


Fig. 1. Diagram of left lateral wall of meso and metathorax of a noctuid moth with the metathoracic episternite heavily outlined in black and the wing area indicated by lines (epm = epimaron; eps = episternite; sa = subalar plate; scu = scutum).

and Smith), and *Pyrrharctia isabella* (J. E. Smith), but bit into them if they were quiet. However, having tasted the moth, the bats spat out the *H. tessellaris* and *H. clymene*, and ate the *P. isabella* (Dunning, 1968), apparently a Batesian mimic of the other two species. Coutts et al. (1973) observed that captive *M. lucifugus* and *Eptesicus fuscus* (Palisot de Beauvois) (Chiroptera: Vespertilionidae) bit into and then rejected dead or quiet *Cynnia tenera* Hubner.

Fig. 2. Scanning electron micrographs of the left (except d and g) metathoracic episternites of: (a) *Euthisanotia unio* Hubner (Concord, Massachusetts); (b) *Phragmatobia assimilians* Newman and Donahue (Edmonton, Alberta); (c) *Phragmatobia fuliginosa* L. (Suisse Valais); (d) *Hypoprepia fucosa* Hubner (Concord, Massachusetts); (e) *Hypoprepia cadaverosa* Strecker (Greer Rd, White Mountains, Arizona); (f) *Hypoprepia miniata* (Kirby) (Attons Lake, Saskatchewan); (g) *Clemensia albata* Packard (Bobcaygeon, Ontario); (h) *Turuptiana permaculata* Walker (Buena Vista, Colorado); (i) *Spilosoma congrum* (Walker) (Lac Mondor, Quebec). Scale indicates 1 mm.



Dunning & Roeder (1965) showed that flying *M. lucifugus* veered away from their prey (moths or 'tossed mealworms') when confronted with tape-recorded microtymbal sounds as they closed with their prey. However, one of Dunning's (1968) captive bats learned to distinguish between the noises of *P. isabella* and *H. clymene* and *H. tessellaris* indicating that different moths produce different noises.

These behavioural considerations and the possibility of marked species differences in microtymbal systems of arctiids led us to make a preliminary survey to determine the incidence of microtymbals in this group. The following is a brief presentation of some of our anatomical findings which may be of interest to lepidopterists.

Figs. 2 and 3 are scanning electron micrographs of the metathoracic episternites of specimens obtained from collections at the Entomology Research Institute, Canada Department of Agriculture, and Carleton University. It is evident from the micrographs that the details of the microtymbals vary considerably both within and between genera. Sexual dimorphism, if it occurs, was not investigated. The metathoracic episternite of a noctuid, *Euthisanotia unio* Hubner, is shown for comparison (Fig. 2a).

Well developed microtymbals occur on the metathoracic episternites of the following species: *Phragmatobia assimilians* Newman and Donahue (Fig. 2b), *Phragmatobia fuliginosa* L. (Fig. 2c), *Phragmatobia lineata* Newman and Donahue, *Hypoprepia fucosa* Hubner (Fig. 2d), *Hypoprepia cadaverosa* Strecker (Fig. 2e), *Hypoprepia miniata* (Kirby) (Fig. 2f), *Clemensia albata* Packard (Fig. 2g), *Cisthene nexa* Boisduval, *Crambidia casta* Sanborn, *Crambidia pallida* Packard, *Halysidota tessellaris* (Fig. 3a), *Halysidota maculata* (Harris), *Hemihyalea labecula* Grote (Fig. 3d), *Pyrrharctia isabella* (Fig. 3f), *Cynia tenera* (Fig. 3g), *Euchaetias egle* (Drury) (Fig. 3h), and *Utethesia ornatrix bella* (Fig. 3i).

The following species have poorly developed microtymbals: *Turuptiana permaculata* Walker (Fig. 2h), *Estigmene acrea* (Drury),

→

Fig. 3. Scanning electron micrographs of the left (except c, e, and h) metathoracic episternites of: (a) *Halysidota tessellaris* Abbot and Smith (Chaffey's Locks, Ontario); (b) *Halysidota argentata* Packard (Nanaimo, British Columbia); (c) *Halysidota caryae* (Harris) (Normandale, Ontario); (d) *Hemihyalea labecula* Grote (Durango, Colorado); (e) *Haploa clymene* (Brown) (Arrowhead Lake, Myrtle Beach, South Carolina); (f) *Pyrrharctia isabella* (J. E. Smith) (Lac Mondor, Quebec); (g) *Cynia tenera* Hubner (Chaffey's Locks, Ontario); (h) *Euchaetias egle* (Drury) (Concord, Massachusetts); (i) *Utethesia ornatrix bella* (L.) (Punta Gorda, Florida). Scale indicates 1 mm.



Spilosoma congrum (Walker) (Fig. 2i), *Arachnis maia* Ottolengui, *Spilosoma virginicum* (Fabricius), *Arctia caja*, *Platarctia parthenos* (Harris), and *Halysidota caryae* (Harris) (Fig. 3c), and in *Holomelina ferruginosa* (Walker) and *Halysidota argentata* Packard (Fig. 3b), they are absent.

The details of the surface of the microtymbals of *U. o. bella* (Fig. 3i) are strikingly different from those of the other arctiids mentioned.

Forbes & Franclemont (1957) considered using the 'striated band' of the Arctiidae as a taxonomic character but noted that it varied markedly in species considered on other grounds to be closely related. Their finding is strikingly confirmed by an examination of Figs. 2 and 3. Thus, the two species of *Phragmatobia* (Fig. 2b and c) and the three species of *Halysidota* (Fig. 3a, b, and c) show marked differences in the form and degree of development of the microtymbals. At the same time, the three species of *Hypoprepia* (Figs. 2d, e, and f) have microtymbals which are quite similar in form and arrangement. It will be interesting to see if microtymbal morphology correlates closely with other characteristics used in the classification of arctiids.

ACKNOWLEDGMENTS

We thank Drs. E. G. Munroe and E. A. Arnason for providing us with the specimens. We are especially grateful to Mr. L. E. C. Ling who took the micrographs of the uncoated specimens at low voltage using the techniques described by Howden & Ling (1973). We are also grateful to Drs. E. G. Munroe and H. F. Howden for critically examining the manuscript and to Dr. E. G. Munroe and Rev. J. C. E. Riotte for encouraging us in this survey. Rev. Riotte kindly checked and corrected the names of the moths. This study was supported by National Research Council of Canada Operating and Equipment Grants to MBF and by a Career Award from the National Institute of Health, United States of America, to KDR.

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NEW STATE RECORDS FOR INDIANA AND ILLINOIS

On 22 July 1973, while collecting *Lycæides melissa samuelis* (Edwards) in the vicinity of Griffith, Lake Co., Indiana, I took a pair of *Problema byssus* (Edwards), a slightly worn male and a fresh female, the first recorded from that state that I had knowledge of at the time. Identification was kindly verified by Mr. Ernest M. Shull, co-author of an annotated list of the butterflies of Indiana (1972, *J. Lep. Soc.* 26: 13–24). According to Mr. Shull who, along with Mr. F. Sidney Badger, has carried out intensive collecting and study in Indiana, these are the first officially recorded specimens for that state. Both specimens have been placed in the private collection of Mr. Shull.

On 24 June 1973, I took two fresh males of the color form *pallida* of *Thymelicus lineola* (Ochsenheimer) in Spears Woods Forest Preserve, Cook Co., Illinois. According to word received from the Illinois Natural History Survey, these are the first records from Illinois. Both specimens have been placed in the permanent Survey collections.

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FEEDING AND SURVIVAL OF *CECROPIA* (SATURNIIDAE) LARVAE ON VARIOUS PLANT SPECIES

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During the course of our studies of the cecropia moth, *Hyalophora cecropia* (L.), we found a large proportion of cocoons in low shrubs. We suspected that many of these shrubs, particularly species of *Juniperus* and *Taxus*, do not support larval growth, and that the presence of cocoons on them is evidence that pre-spinning larvae wandered to them from the foodplant. Most of the shrubs in question are not included on published lists of the hostplants of cecropia, but since this does not prove that cecropia larvae could not feed on them, we made the feeding trials described below.

There is some doubt as to whether or not all of the species on the published "foodplant lists" of cecropia are actually eaten by cecropia larvae. Brodie's (1882) list is reliable since he included only plants on which larvae had been found feeding in the field. On the other hand, Marsh's (1937) list is of dubious value since he included plants on which he had found cocoons but had not seen larvae. Tietz (1958) compiled a long list, but, unfortunately, did not state the evidence upon which the plants were included.

MATERIALS AND METHODS

Most cocoons were collected in residential areas, principally in the twin cities of Champaign and Urbana, Illinois, although a few were found in nearby small towns. A small number came from rural areas, mostly from ditch banks, railroad rights-of-way, roadsides and fence rows.

The larvae used in feeding trials were the progeny of wild parents which had been collected as described above. After mating in the laboratory, females were placed in large paper bags where they oviposited. Before hatching occurred, small bits of paper bearing the eggs were snipped out and transferred to petri dishes. The unfed first instars used in the first series of tests were indiscriminately selected within a

half-hour of hatching. The partly grown larvae used in the second series were indiscriminately selected from groups of larvae reared in nylon mesh sleeves on apple trees (*Malus pumila*) essentially as described by Telfer (1967).

Plants of 118 species were tested for their ability to support the growth of first instar larvae. Each species was tested with at least three replicates. Species on which no larvae survived the first stadium in the initial test were retested with an additional three replicates. Each replicate consisted of ten larvae confined with foliage in a 10 cm petri dish lined with a disc of moist filter paper. The newly hatched larvae were weighed in groups of ten and immediately placed in the dishes. Undamaged foliage, collected daily from plants growing in full sunlight, was sealed in plastic bags and stored in a refrigerator until used later the same day. The dishes were kept under constant illumination and at a temperature of $23 \pm 1^\circ \text{C}$. At least once a day fresh food was added, and dead larvae, left over food, and feces were removed. Feces were dried immediately, and eventually the aggregate for each replicate was redried to a constant weight at 100°C (see Waldbauer, 1964). This weight was divided by the sum of the number of larvae feeding on each test day to yield the mean dry weight of feces passed per larva per day. Larvae were weighed and considered to have survived the stadium as soon as they had spun a molting pad. Dishes with moist filter paper but no food, and dishes with *Acer saccharinum* foliage served as negative and positive controls respectively. A group of tests was started on each of three days. Each group had its own controls, but since the controls differed by very little they have been lumped in Table 2.

A few plants were also tested with two groups of partly grown larvae. Each group consisted of five larvae confined in a sleeve on a branch of a living plant in the field. They were transferred to the test plant from apple foliage, one group just before the molt to the fifth stadium and the other on the seventh day of the fifth stadium. Apple branches with leaves served as positive controls, and defoliated branches of the test plant as negative controls.

RESULTS AND DISCUSSION

Table 1 lists the plants on which we found 1% or more of the cocoons collected during this study. Almost all of the cocoons from rural areas were on *Salix interior*, a shrubby willow which grows wild on ditch banks and in other moist places, but is not planted in urban areas. A few of the other listed species grow wild in this area, but with few

TABLE 1. The location of cecropia cocoons found during the collecting seasons of 1967-68, 1968-69 and 1969-70. Only those plants on which 1% or more of the total was found are named. Species which do not serve as foodplants for cecropia are marked with an asterisk.

Locations	Cocoons Found	
	Number	% of total
<i>Acer saccharinum</i> L.	1,074	34.8
* <i>Juniperus</i> spp.	278	9.0
<i>Salix interior</i> Rowlee	254	8.2
<i>Betula pendula</i> Roth.	168	5.4
<i>Acer rubrum</i> L.	136	4.4
<i>Rhamnus frangula</i> L.	132†	4.3
<i>Malus</i> spp. (Including <i>pumila</i>)	127	4.1
* <i>Ligustrum vulgare</i> L.	115	3.7
* <i>Taxus media</i> Rehd.	102	3.3
<i>Betula populifolia</i> Marsh.	90	2.9
<i>Platanus occidentalis</i> L.	66	2.1
<i>Betula papyrifera</i> Marsh.	52	1.7
<i>Cornus stolonifera</i> Michx. and <i>C. alba</i> L.	46†	1.5
* <i>Euonymus</i> spp. (not <i>alatus</i>)	38	1.2
Other plants	355	11.5
Fences and buildings	51	1.7
	3,084	99.8

† See text.

exceptions we found cocoons only on cultivated specimens in urban areas.

The data of Table 1 do not reflect the importance to cecropia in this area of *Rhamnus frangula* and the two species of *Cornus*. In an earlier study (Waldbauer & Sternburg, 1967) we found cocoons abundantly on *Cornus stolonifera* and *C. alba*. However, during the present study we did little collecting from *Cornus* because most plants of these species in this area were included in another study of cecropia. *R. frangula* was formerly scarce in this area, but has become a popular hedge plant since we began our studies of cecropia in 1965; the great majority of cocoons from *R. frangula* were collected during the last year of the present study.

Over 12% of the cocoons were found on shrubby conifers, *Juniperus* spp. and *Taxus media*, but only if these conifers were close to trees, particularly *Acer saccharinum* and *Betula* spp., which are important foodplants of cecropia in this area. We hypothesized that the larvae do not feed on these conifers, but migrate to them from their foodplants when they are ready to spin cocoons. The observations recorded below

TABLE 2. Survival, growth and feces production of first instar cecropia larvae on the leaves of various woody plants. All plants were tested with three replicates of ten larvae each except those marked with an asterisk, which were tested with six replicates of ten each, and *A. saccharinum* and moist filter paper which were tested with 9 replicates of ten each.

Plants	% Survival	Duration of instar (days)		Mg fresh weight gained		Mg dry feces/ larva/day	
		Mean	Range	Mean	Range	Mean	Range
Plants listed in Table 1							
<i>Acer rubrum</i> L.	96.6	6.0	6.0-6.0	224	217-242	39.5	37.9-41.0
<i>A. saccharinum</i> L.	95.0	6.3	5.0-7.0	202	167-233	33.6	30.0-38.9
<i>Betula papyrifera</i> Marsh.	83.3	3.8	3.5-4.0	329	309-345	39.9	34.1-44.2
<i>B. pendula</i> Roth.	90.0	4.6	4.5-5.0	358	336-395	32.6	24.8-36.8
<i>Cornus alba</i> L.	93.3	4.3	4.0-5.0	235	193-263	16.5	12.8-18.7
<i>C. stolonifera</i> Michx.	96.6	4.6	4.0-5.5	237	216-276	20.3	20.0-22.8
<i>Euonymus alatus</i> Sieb.	90.0	8.8	8.0-9.5	180	166-203	22.7	20.4-24.3
<i>E. fortunei</i> Trucz.*	0	—	—	—	—	0.1	0.1-0.3
<i>E. yedoensis</i> Koeh.*	0	—	—	—	—	2.9	1.2-4.2
<i>Juniperus chinensis</i> L.*	1.6	8.0	—	80	—	4.6	2.9-6.8
<i>J. communis</i> L.*	0	—	—	—	—	0.3	0.1-0.6
<i>J. procumbens</i> Endl.*	0	—	—	—	—	4.9	2.0-8.9
<i>J. sabina</i> L.*	0	—	—	—	—	0.7	0.5-0.9
<i>J. virginiana</i> L.*	0	—	—	—	—	0.3	0.2-0.3
<i>Ligustrum vulgare</i> L.	3.3	8.0	—	244	—	12.9	9.2-15.6
<i>Malus adstringens</i> Zabel.	96.6	5.3	5.0-6.0	279	232-264	30.9	26.5-33.3
<i>M. arnoldiana</i> Sarg.	93.3	5.3	5.0-5.5	311	304-320	31.1	28.5-33.2
<i>M. atrosanguinea</i> Scheid.	96.6	5.3	5.0-6.0	252	232-264	30.8	28.0-32.9
<i>M. floribunda</i> Sieb.	83.3	5.0	5.0-5.0	186	145-207	27.4	26.8-28.4
<i>M. pumila</i> Mill.	93.0	4.5	4.0-5.0	311	305-321	49.2	44.3-56.4
<i>Plantanus</i>							
<i>occidentalis</i> L.	100.0	5.5	5.5-5.5	252	217-261	28.7	28.5-28.9
<i>Rhamnus frangula</i> L.	100.0	4.3	4.0-4.5	288	282-300	27.2	25.8-29.8
<i>Salix interior</i> Rowlee	86.6	3.5	3.5-3.5	277	258-285	32.8	30.9-35.5
<i>Taxus media</i> Rehd.*	0	—	—	—	—	0.6	0.4-0.7
Others							
<i>Larix decidua</i> Mill.	90.0	5.0	5.0-5.0	180	168-188	28.8	25.9-33.1
<i>L. laricina</i> (Du Roi)							
K. Koch	83.3	4.5	4.5-4.5	301	265-327	31.7	30.4-33.1
<i>Pinus flexilis</i> James	0	—	—	—	—	2.6	1.0-5.8
<i>P. nigra</i> Arnold*	0	—	—	—	—	0.1	0.1-0.2
<i>P. strobus</i> L.	11.6	11.3	11.0-11.5	171	170-172	5.6	3.6-11.0
<i>P. sylvestris</i> L.*	0	—	—	—	—	0.5	0.4-0.8
<i>Taxodium distichum</i>							
(L.) Rich.	3.3	14.0	—	211	—	1.8	0.5-3.7
<i>Thuja occidentalis</i> L.*	0	—	—	—	—	2.5	1.5-2.9
<i>Tsuga canadensis</i>							
(L.) Carr.	80.0	6.5	6.0-7.5	121	95-155	13.3	12.2-14.0
Moist filter paper	0	—	—	—	—	0.2	0.4-0.4

show this hypothesis to be correct and, furthermore, show that the cocoons spun on certain angiosperms (see Table 1) are probably also spun by migrants from other plants.

We have found wild third to fifth instar larvae in the field feeding on the following plants: *Acer platanoides*, *A. saccharinum*; *Betula papyrifera*, *B. pendula*, *B. populifolia*; *Cornus alba*, *C. stolonifera*; *Lonicera fragrantissima* Linden and Paxton, *L. tartarica* L.; *Malus pumila*, *Malus* spp.; *Paeonia officinalis* L.; *Prunus serotina*; *Rhamnus frangula*; *Rhus typhina*; *Salix interior*; and *Spirea alba*. We have observed successful development to the adult stage on all of these except *A. platanoides*, *B. populifolia*, *Malus* spp. other than *M. pumila*, and *S. alba*. We have no reason to suspect that the latter would not support complete development.

Table 2 gives the results of some of the feeding trials with first instars. In the upper section of the table appear the plants on which most cocoons were found (see Table 1). In the lower section are listed other conifers, some of which, to our surprise, supported good growth.

Fifteen of the species on which we had found large numbers of cocoons supported apparently normal growth to the end of the first stadium; 83% or more of the test larvae survived the stadium, gained a fresh weight of 180 mg or more—usually in six days or less, and ate at a more or less normal rate as judged by the rate at which they passed feces. This does not prove that development could have been completed on these plants. However, we have found fifth instars feeding in the field on all of these plants except *Acer rubrum* and *Platanus occidentalis*. Thus there is almost no question that cecropia can complete development on thirteen of these plants, and there is no reason to assume that it cannot complete development on *A. rubrum* and *P. occidentalis*. It is, therefore, unlikely that cocoons found on these plants were spun by larvae which had wandered from some other species of plant.

The other plants on which large numbers of cocoons had been found, nine species of *Euonymus*, *Juniperus*, *Ligustrum* and *Taxus*, were usually eaten only in minute quantities and did not support growth or, at best, supported the slow growth of only one larva out of a group of 30 or 60 (see Table 2, *J. chinensis* and *L. vulgare*). The inability of these plants to support the growth of first instars proves that they are not usual food plants of cecropia. Therefore, cocoons found on them must have been spun by larvae which had moved from some other species of plant, the movement probably occurring only after growth had been completed.

It is possible that plants which do not support first instars may sup-

TABLE 3. Survival of partly grown cecropia larvae transferred from *Malus pumila* to other plants. Each plant was tested with two groups of five larvae.

Plants	Larvae transferred at:			
	end of 4th instar		7th day of 5th instar	
	No. surviving to: pupa	No. surviving to: adult	No. surviving to: pupa	No. surviving to: adult
Test plants				
<i>Juniperus chinensis</i> L.	0	0	0	0
<i>J. communis</i> L.	0	0	0	0
<i>J. procumbens</i> Endl.	0	0	0	0
<i>J. virginiana</i> L.	0	0	0	0
<i>Ligustrum vulgare</i> L.	4	1	3	0
<i>Taxus media</i> Rehd.	0	0	0	0
Controls				
<i>Malus pumila</i> Mill.	5	5	5	5
Defoliated branch	0	0	0	0

port the growth of partly grown larvae which may move to them from a more favorable plant. We have seen no evidence of such moves, and doubt that they are of more than rare occurrence. Furthermore, feeding tests with partly grown larvae (Table 3) indicate that although an occasional partly grown migrant might survive by eating the foliage of *Ligustrum vulgare*, there will be no survival on *Juniperus* or *Taxus*, even if the migrants feed on one of the usual foodplants until the middle of the last stadium. *Taxus* is probably toxic since larvae which ate small quantities died sooner than controls on a defoliated branch of *Taxus*.

Three of the four species in the genus *Hyalophora* apparently feed only on non-conifers, while the remaining species, the northern *H. columbia* (S. I. Smith), appears to feed exclusively on the tamarack, *Larix laricina*, (Ferguson, 1971). It is thus of more than passing interest that some conifers, most notably *Larix laricina*, *L. decidua*, and *Tsuga canadensis*, support good survival and growth by cecropia during the first stadium (Table 2). Furthermore, during the summer of 1973 we transferred five young third-instar cecropia from an apple to a small European larch (*L. decidua*) growing outdoors. Two disappeared from the sleeve, but the remaining three spun apparently normal cocoons. Whether or not they survive to emerge as adults remains to be seen since they are still in diapause. Recently Collins (1973) reported that the two western species can survive on some conifers. *H. gloveri* (Strecker) has been reared on *L. decidua*, *L. laricina* and *Pseudotsuga menziesii* (Mirb.). *H. euryalus* (Boisduval) has been found in the field feeding on *P. menziesii* and has been reared in captivity on the same

plant. It would seem that all *Hyalophora* are potentially able to utilize conifers, but that this ability has been selected for only in *H. columbia*.

Many plants in addition to those listed in Table 2 were tested with first instars, but it would require too much space to list the data in detail. Plants on which over 70% of the larvae survived the first stadium are:

Acer platanoides Michx., *A. negundo* L.; *Aesculus octandra* Marsh.; *Carya ovata* (Mill.) K. Koch, *C. illinoensis* (Wangenh.) K. Koch; *Castanea mollissima* Bl.; *Chaenomeles lagenaria* Koidz.; *Cornus florida* L., *C. racemosa* Lam., *C. sanguinea* L.; *Cotoneaster multiflora* Bge.; *Crataegus crus-gali* L., *C. molli* Scheel.; *Diospyros virginiana* L.; *Fraxinus pennsylvanica* Marsh.; *Hamamelis virginiana* L.; *Juglans nigra* L.; *Liquidambar styraciflua* L.; *Lonicera tartarica* L.; *Maclura pomifera* (Raf.) Schneid.; *Nyssa sylvatica* Marsh.; *Populus deltoides* Bartr., *P. laurifolia* Ledeb.; *Prunus americana* Marsh., *P. serotina* Ehrh.; *Pyrus communis* L.; *Quercus alba* L., *Q. imbricaria* Michx., *Q. macrocarpa* Michx., *Q. muhlenbergii* Engelm., *Q. rubra* L.; *Rhus typhina* L.; *Robinia pseudoacacia* L.; *Salix babylonica* L.; *Sambucus canadensis* L.; **Sanicula smallii* Bicknell; *Spirea alba* Du Roi; *Syringa chinensis* Willd.; *Tilia americana* L., *T. euchlora* Koch., *T. tomentosa* Moench.; *Viburnum dentatum* L., *V. tomentosum* Thunb.

Plants on which there was survival, but less than 70% are:

Acer saccharum Marsh.; **Asclepias syriaca* L.; *Betula alleghaniensis* Britton, *B. nigra* L.; *Cotinus americana* Nutt.; *Deutzia lemoine* Hort.; *Elaeagnus angustifolia* L.; *Forsythia viridissima* Lindl.; *Fraxinus americana* L.; *Ginkgo biloba* L.; *Gleditsia triacanthos* L.; *Halesia carolina* L.; **Lactuca scariola* L.; *Lonicera japonica* Thunb.; *Morus alba* L.; **Plantago rugelii* L.; *Rhus glabra* L.; *Salix nigra* Marsh.; *Syringa vulgaris* L.; **Taraxacum officinale* Weber; *Tilia platyphyllos* Scop.; *Ulmus americana* L., *U. carpinifolia* Gleditsch., *U. parvifolia* Jacq.

Plants on which no larvae survived are:

**Adiantum pedatum* L.; *Ailanthus altissima* (Mill.) Swingle; *Asimina triloba* Dunal.; *Campsis radicans* (L.) Seem.; *Catalpa bignonioides* Walt.; *Celtis occidentalis* L.; *Cercis canadensis* L.; **Chenopodium album* L.; *Kolkwitzia amabilis* Graebn.; *Liriodendron tulipifera* L.; **Nicotiana tabacum* L.; *Philadelphus coronarius* L.; *Populus alba* L.; **Sonchus asper* (L.) Hill; **Verbascum thapsus* L.; **Viola* sp.; *Vitis* sp.; **Zea mays* L.

In the above list herbaceous plants (as opposed to woody) are marked with an asterisk. Larvae survived on only five of the eleven non-woody plants tested. These were: *Asclepias syriaca*—30%, *Lactuca scariola*—3%, *Plantago rugelii*—53%, *Sanicula smallii*—83% and *Taraxacum officinale*—63%. Almost without exception the recorded natural food-plants of cecropia are woody; the only indisputable exception is *Paeonia officinalis* (see above, and Waldbauer & Sternburg, 1967).

Table 2 shows considerable variation in response to the various species of acceptable plants, particularly in the duration of the instar, weight gained and the weight of feces passed per day. Large differences in the latter value (cf., for example, *Malus pumila* and *Cornus alba*) suggest large differences in the rates at which different plants are eaten.

However, the weight of feces is only an approximate indication of the rate of intake since the former will vary not only with the weight of food ingested, but also with the proportion of the ingested food which is assimilated and expended for growth and the maintenance of metabolism (Waldbauer, 1964).

This study makes the following major points:

1. It confirms past observations that *cecropia* larvae are able to feed and survive on a wide variety of woody angiosperms.

2. It shows that neither first nor fifth instar larvae are able to survive on certain plants on which cocoons are commonly found, establishing that the larvae must have moved to them after completing their feeding on some other species of plant.

3. It shows that first instars are able to survive on certain species of conifers, including *Larix laricina*, the foodplant of the closely related *Hyalophora columbia*.

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NOTE ADDED IN PROOF: The three pupae from larvae matured on *Larix decidua* produced three normal adult moths in 1974: 21 May, ♂; 29 June, ♂; 30 June, ♀.

SIZE VARIATION IN *EUPTOIETA CLAUDIA* IN MISSISSIPPI (NYMPHALIDAE)¹

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Variation in size of individuals of *Euptoieta claudia* (Cramer) has been reported, but no quantitative data have been found in the literature. Mather & Mather (1958) wrote of Mississippi that, "February specimens are characteristically very small." Harris (1972) wrote of Georgia that, "The individuals of *E. claudia* vary in size, and an interesting series may

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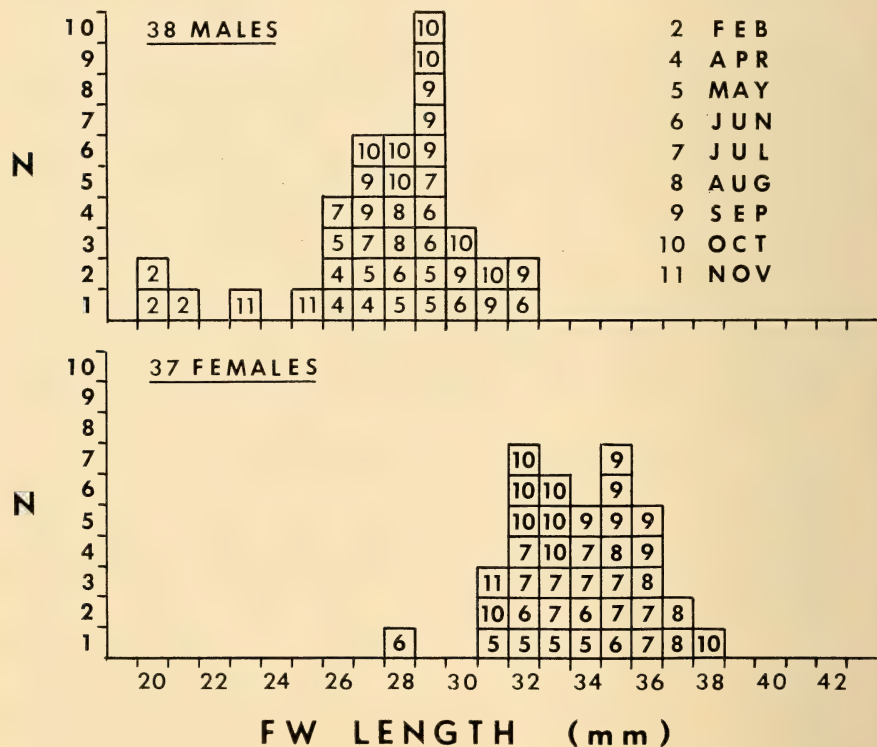


Fig. 1. Forewing-length distribution of 75 Mississippi specimens of *Euptoieta claudia*.

TABLE 1. Data on 75 specimens of *Euptoieta claudia* from Mississippi.

Date	Locality	Collector	FW length (mm)	Sex
17 Feb 52	Clinton, Hinds	B. Mather	21	♂
22 Feb 49	Clinton, Hinds	B. Mather	20	♂
22 Feb 49	Clinton, Hinds	B. Mather	20	♂
15 Apr 52	Brooklyn, Forrest	B. D. Valentine	26	♂
19 Apr 59	Clinton, Hinds	M. & E. Roshore	26	♂
26 Apr 52	Jackson, Hinds	B. Mather	27	♂
3 May 59	Vicksburg, Warren	B. Mather	33	♀
3 May 59	Vicksburg, Warren	B. Mather	26	♂
8 May 48	Clinton, Hinds	B. Mather	31	♀
9 May 59	Jackson, Hinds	B. Mather	29	♂
15 May 48	Clinton, Hinds	B. Mather	27	♂
20 May 60	Jackson, Hinds	B. Mather	28	♂
20 May 65	Bynum Mounds, Chickasaw	M. & E. Roshore	29	♂
21 May 65	Thrasher, Prentiss	M. & E. Roshore	32	♀
25 May 58	Brownsville, Hinds	M. & E. Roshore	34	♀
5 Jun 70	Gulfport, Harrison	B. Mather	28	♀
6 Jun 70	Bay St. Louis, Hancock	B. Mather	28	♂
9 Jun 57	Clinton, Hinds	M. & E. Roshore	29	♂
9 Jun 57	Clinton, Hinds	M. & E. Roshore	32	♂
9 Jun 57	Clinton, Hinds	M. & E. Roshore	29	♂
9 Jun 57	Clinton, Hinds	M. & E. Roshore	30	♂
9 Jun 57	Clinton, Hinds	B. Mather	32	♀
12 Jun 60	Clinton, Hinds	B. Mather	35	♀
29 Jun 47	Clinton, Hinds	B. Mather	34	♀
3 Jul 55	Clinton, Hinds	B. Mather	27	♂
3 Jul 55	Clinton, Hinds	B. Mather	29	♂
3 Jul 55	Clinton, Hinds	B. Mather	36	♀
6 Jul 57	Jackson, Hinds	B. Mather	35	♀
7 Jul 54	Clinton, Hinds	B. Mather	36	♀
13 Jul 58	Brownsville, Hinds	B. Mather	33	♀
15 Jul 51	Clinton, Hinds	B. Mather	26	♂
16 Jul 55	Jackson, Hinds	B. Mather	34	♀
19 Jul 52	Clinton, Hinds	B. Mather	34	♀
20 Jul 58	Clinton, Hinds	B. Mather	32	♀
21 Jul 57	Clinton, Hinds	M. & E. Roshore	35	♀
22 Jul 59	Tishomingo St. Pk., Tishomingo	M. & E. Roshore	32	♀
31 Jul 55	Bovina, Warren	B. Mather	33	♀
3 Aug 57	Jackson, Hinds	B. Mather	28	♂
3 Aug 57	Jackson, Hinds	B. Mather	28	♂
11 Aug 57	Clinton, Hinds	B. Mather	35	♀
14 Aug 49	Clinton, Hinds	B. Mather	37	♀
16 Aug 59	Clinton, Hinds	B. Mather	36	♀
24 Aug 57	Brownsville, Hinds	B. Mather	37	♀
1 Sep 46	Clinton, Hinds	B. Mather	32	♂
1 Sep 57	Bolton, Hinds	B. Mather	30	♂
1 Sep 57	Clinton, Hinds	M. & E. Roshore	36	♀

TABLE 1. (Continued)

Date	Locality	Collector	FW length (mm)	Sex
2 Sep 56	Brownsville, Hinds	B. Mather	29	♂
2 Sep 57	Bolton, Hinds	M. & E. Roshore	31	♂
5 Sep 49	Clinton, Hinds	B. Mather	29	♂
12 Sep 71	Clinton, Hinds	B. Mather	35	♀
19 Sep 53	Waynesboro, Wayne	B. Mather	29	♂
23 Sep 72	Jackson, Hinds	B. Mather	35	♀
25 Sep 54	Jackson, Hinds	B. Mather	34	♀
26 Sep 68	Hattiesburg, Forrest	E. Reid	36	♀
26 Sep 68	Hattiesburg, Forrest	E. Reid	27	♂
26 Sep 68	Hattiesburg, Forrest	E. Reid	27	♂
28 Sep 58	Jackson, Hinds	B. Mather	35	♀
3 Oct 59	Clinton, Hinds	M. & E. Roshore	31	♀
5 Oct 52	Clinton, Hinds	B. Mather	38	♀
5 Oct 58	Brownsville, Hinds	M. & E. Roshore	28	♂
6 Oct 51	Clinton, Hinds	B. Mather	29	♂
6 Oct 51	Clinton, Hinds	B. Mather	33	♀
9 Oct 51	Ridgeland, Madison	B. Mather	29	♂
11 Oct 69	Ft. Adams, Wilkinson	B. Mather	32	♀
12 Oct 52	Clinton, Hinds	B. Mather	28	♂
12 Oct 52	Clinton, Hinds	B. Mather	27	♂
12 Oct 69	Pinckneyville, Wilkinson	B. Mather	31	♂
12 Oct 69	Pinckneyville, Wilkinson	B. Mather	32	♀
13 Oct 56	Vicksburg, Warren	B. Mather	32	♀
13 Oct 56	Jackson, Hinds	B. Mather	33	♀
15 Oct 55	Jackson, Hinds	B. Mather	30	♂
23 Oct 71	Jackson, Hinds	B. Mather	33	♀
4 Nov 51	Clinton, Hinds	B. Mather	31	♀
7 Nov 48	Clinton, Hinds	B. Mather	25	♂
11 Nov 51	Hermanville, Claiborne	B. Mather	23	♂

be obtained. Very small specimens may be found at times, especially in early spring, and unusually large ones may be found in the summer." Rahn (1972) reported on five specimens taken 18–21 August 1970 in North and South Dakota. He stated that these showed a "wing span range from 1¾" to 2". Measurements made on the figure in his paper, adjusted for scale reduction in reproduction, indicate forewing lengths of 20, 24, 30, 30, and 32 mm.

A group of 75 Mississippi specimens was examined; results are given in Table 1. Forewing-length distributions for males and females are shown in Fig. 1. As previously noted, very small specimens have been taken in February. Other small specimens were taken in November; but there does not appear to be the progressive increase in size through the season that characterises such species as *Colias eurytheme* Boisduval or *Papilio glaucus* Linnaeus. The major factors affecting size in *E. claudia* appear

to be (a) sex, females are typically significantly larger than males; and (b) winter, November and February specimens are characteristically smaller than average. The size range of the Mississippi series is 20 to 38 mm (1 to 1.9). The range of the series of five August specimens reported by Rahn (1972) was 20 to 32 mm (1 to 1.6). The size range for six Mississippi August specimens was 28 to 37 mm (1 to 1.3).

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PHYCIODES MYLITTA (NYMPHALIDAE) ON VANCOUVER ISLAND

In Jones' "Annotated Check List of the Macrolepidoptera of British Columbia" (1951), *Phyciodes mylitta* is listed as occurring in a number of localities in mainland British Columbia including the coast adjacent to Vancouver Island, but there were at the time no records for Vancouver Island. I have myself collected intensively over a large part of Vancouver Island during the past 30 years, without encountering *P. mylitta* before 1972.

In August of that year *P. mylitta* turned up in Bright Angel Park near Duncan. The first specimens were handed to me by a friend, Mrs. Betty McKinnon, who said that they were then quite plentiful in the park area. Looking at the butterflies through the semi-transparent envelopes in which they were packed, I took them for *Phyciodes campestris* Behr. which I have often taken on Vancouver Island, though I was surprised at the late date, 10 August. I did not examine them more closely until late the following winter, when I at once saw that they were not *P. campestris*. Later, I sent some examples to Dr. dos Passos, who pronounced them typical *Phyciodes mylitta*.

The following April, *P. mylitta* showed up in a number of localities from Victoria on the southern tip of the Island north about 40 miles to Chemainus. Either the species had maintained itself in such small numbers as to escape detection, and then suddenly exploded; or it had gained access to Vancouver Island two years ago and built up a large population with amazing speed. In some respects the case resembles that of *Coenonympha tullia*, which after being confined to the immediate vicinity of Victoria until about 1965, suddenly started to spread northward, again coming to a stop near Chemainus. The latter species, however, was always very common near Victoria.

I cannot account for the flight season for *P. mylitta* as given by Jones, he states merely "June." Last year I observed a spring brood starting to fly very early in April, followed by a summer flight in July and August. *P. campestris* here is single brooded, flying in June and early July.

RICHARD GUPPY, *Thetis Island, British Columbia, Canada.*

GREGARIOUS SEASONAL ROOSTING OF
SMYRNA KARWINSKII ADULTS IN EL SALVADOR
(NYMPHALIDAE)

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Nocturnal gregarious roosting is known to exist in a variety of reputedly unpalatable species of butterflies (Carpenter, 1931; Crane, 1955; Jones, 1930; McFarland, 1970; McNeil, 1937; Poulton, 1931; and our personal observations on the phenomenon in adults of *Dryas iulia iulia* (Fabricius), *Heliconius petiveranus* Doubleday and *H. charitonius* L.). According to A. M. Young (pers. comm.), one case of nocturnal gregarious roosting of a nymphalid, *Marpesia bernia* (Hewitson), has been studied. But apparently a semi-permanent or seasonal, 24 hours a day, six months a year kind of roosting has not been known to exist in any kind of butterfly.

As stated in our preliminary report on communal resting of *Smyrna karwinskii* (1973), we have observed, annually since 1962, adults of *Smyrna karwinskii* (Geyer) resting during the day in groups ranging from 10 to more than 100 individuals, of mixed sex ratio, in cavities of lava walls and tree trunks, and on the underside of concrete slabs roofing alleys between cabins at Cerro Verde (a mountain of about 2000 m elevation overlooking the WNW slope of the Izalco Volcano, about 50 km from San Salvador). In total we have observed the phenomenon 37 days during the months of January, February, March, April, August, November and December in the course of eleven years. In each of these months, in different years, the observations have been repeated several times, except in August (only one time during 1965). In all instances the roosting aggregations observed were situated in the shade, away from direct sunlight. The locations chosen by the groups were always protected from the northern winds, which are usually quite strong from December through February, principally on mountain tops.

On 31 March 1972 we observed five roosting aggregations very closely. One contained 15 adults, a second 20, two about 50 each and a fifth more

than one hundred. Monthly trips were made to the same place from June to November, but not a single group was found during that period. On 23 December, two groups were located, one consisting of 123 individuals (Fig. 1), and a second, some three meters from the first, of 39 (Fig. 2). As usual, both males and females were present, but no sexual activity was noticed. From time to time individuals would depart from the groups, presumably in search of food resources, and sporadically individuals would join the groups.

In order to determine the sex ratio in the aggregations, the one that contained 123 individuals was captured early in the morning of 23 December 1972, using a big bag made of stiff plastic sheet, that when flattened acted as a big paper envelope, immobilizing the butterflies without damaging them. To cause the butterflies to move into the bag, the mouth of it was applied to the concrete, enclosing the whole group, and then moved back and forth until all individuals, except 15 that escaped, were inside. The bag was flattened, keeping the butterflies motionless on their sides, and one by one they were extracted, quickly sexed and counted. Sexing this species is easy due to their sexual dimorphism. The total was 42 males and 66 females. As they were freed, they darted to the surrounding wood, alighting on tree trunks and rocks. During the following 5 hours, there was much flying activity: males chasing females and other males. Some individuals started to alight singly under the roofing slabs, scattered over an area of roughly 40 m. By the time we left we counted 38 individuals. None joined the smaller group, nor had they started to form a new aggregation.

We tried to mark the second smaller group with red spray from a distance, but the group started to disintegrate when the mist reached it, so we stopped this method. Out of the original 39 butterflies in the group, only 18 stayed. We tried then to mark the remaining butterflies individually by capturing each one by hand, giving it a light spray on the right rear underwing and putting it back in place, but the first individual so treated did not stay with the group and flew away. The rest were then left alone for future observations.

On 28 January 1973, about a month later, we visited the same place. The large group was not found. The smaller, though, was at the same place it had been on 23 December, and it had about the same number of individuals as when first sighted. Even the marked one was there, standing conspicuously in the second row. Unfortunately on the following trip to the locality this group was not found again, having been disturbed the week before by some curious tourists, according to the report of one of the guards.

On various occasions females were captured from aggregations and dissected. None had eggs in the abdomen, but considerable amounts of fat tissue were present.

It has been noticed that during the wet season the species is found in lower lands, where the foodplants (several species of *Urticaceae*), are very abundant. During the wet season it is rare to find adults of *Smyrna karwinskii* up in Cerro Verde. Not so during the dry season.

We have collected eggs and larvae of this species during the wet season in the same habitat we have collected eggs and larvae of its more common close relative *Smyrna blomfildia datis* Frühstorfer, which is seldom found at high altitudes (the highest record for *S. b. datis* in El Salvador is one adult captured on the slopes of Cerro Verde, ca. 1600 m, by S. R. Steinhauser in October 1967, pers. comm.), yet we have never found eggs or larvae of *S. karwinskii* in Cerro Verde. It is to be noted that the larvae of *S. karwinskii* are easily distinguished from the larvae of *S. blomfildia datis* by their color. *S. karwinskii* have the body and spines brown, while *S. blomfildia datis* presents four different morphs: body and spines greenish white, body greenish white with black spines, body mostly black with light spines and body mostly black with black spines. In shape and head the two species are much alike.

DISCUSSION

Since the phenomenon was first observed, back in 1962, it had been our assumption that the butterflies were grouped at places where water filtrated and that they were drinking there. But on 31 March 1972 we had a chance to observe five groups from a short distance for a period of seven hours. Not once did we see any individual uncoil its proboscis, nor did we notice any moisture in the concrete, thus eliminating that, as well as the alternative explanation that the grouping was formed to allow use of each other's excreta to recycle fluids, as has been reported by Hessel (1966) for single individuals of *Agathymus aryxna* (Dyar). The fact that the groups are always formed in the shade, away from direct sunlight, also eliminates the possibility that receiving solar heat plays a role in causing the aggregations.

In the unpalatable species, gregarious nocturnal roosting has been viewed as an evolutionary behavior acquired to enhance their unpleasant scent and therefore the chances to effectively deter any approaching predator. *Smyrna karwinskii* adults are not reputed to be distasteful to predators, but no experiment that we know of has been carried out in this respect. We have observed that the larvae when molested extrude a gland located anterad of the prothoracic legs, as its relatives *S.*

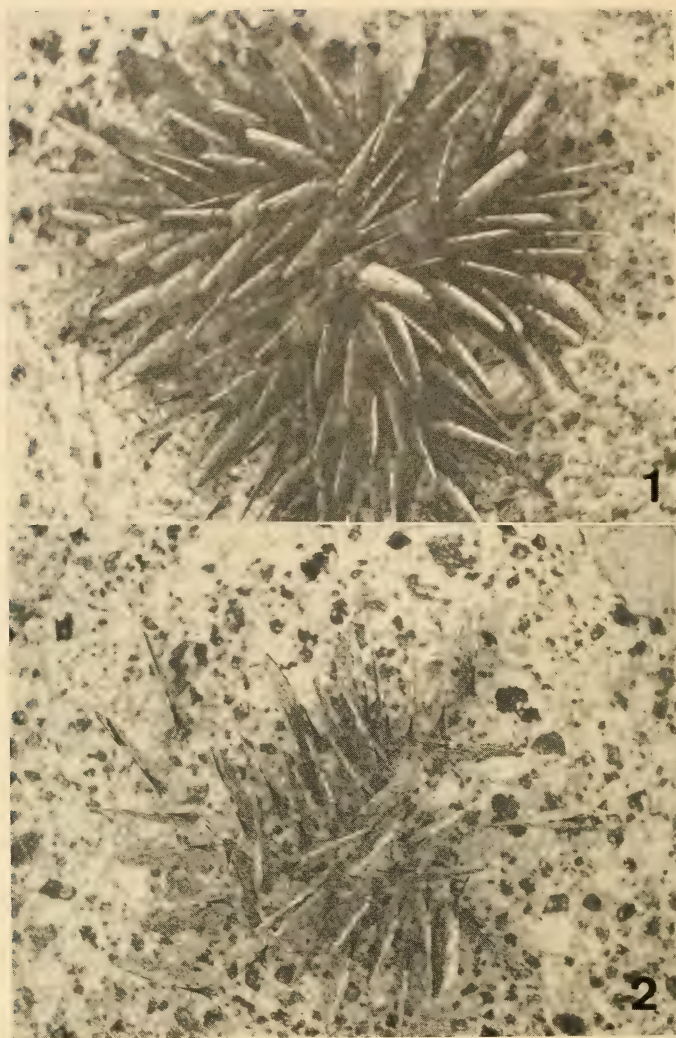
blomfildia datis, *Colobura dirce* L. and *Historis odius* Fabricius do, emitting a scent very faint to humans, presumably to repel potential vertebrate predators (Hemiptera have been found feeding on *Smyrna* spp. larvae). This makes us doubt the palatability of the adults. If after appropriate experiments, this species proves to be distasteful to such predators, the communal roosting habits could be explained for the reasons given above. This mechanism would act only as a chemical repellent, having a passive role, as it is evident that the individuals in the congregation do not have the ability to communicate to the other members of the group when danger is imminent, as individuals can be captured by hand from any place in the group and at any time of the day without causing a reaction from the rest of the individuals. It is necessary to be rather rough to obtain a mass response from the whole aggregation. When this is done the individuals disperse in all directions producing an audible rustling noise with the wings, somewhat like *Hesperiidae*.

Another possible benefit that the congregated individuals seem to derive from their communal roosting is the mimetic effect obtained: the groups look like a dried moss or lichen formation, at least to humans.

The fact that the aggregations are formed at the beginning of the dry season, persist through it and dissolve at the beginning of the wet season, plus the presence of excessive fat tissue and the absence of eggs in the females, seems to point to a case of aestivation in a state very close at least to diapause. Individual diapause would serve the purpose of living through the dry season by itself, but the communal aestivation would have the additional advantage of keeping the sexes together, thus guaranteeing an effective and early encounter, optimizing the chances of early copulations and consequently the production of fertile eggs when weather conditions are once again favorable for larval development.

The fact that individuals abandon the groups from time to time, and the fact that we have witnessed individuals feeding at tree wounds in the neighboring woods, seem to indicate that this is not a case of complete diapause, but a partial one that calls for a close and reliable source of food, even if only periodically needed by organisms whose metabolism is greatly slowed down.

There seems to be a degree of organization in the groups with some kind of discrimination between individuals belonging to different ones. The organization is suggested by the consistent way the groups are formed: there is a nucleus of several individuals with the heads pointing inwards, sometimes so close as to have their upraised antennae almost touching, surrounded by tightly packed rows, forming circles or partial



Figs. 1 and 2. Roosting assemblies of *Smyrna karwinskii*: 1, 123 adults; 2, 39 adults. Both photographed at Cerro Verde, 23 December 1972.

circles of individuals with the heads again pointing inwards, and with the antennae touching a member of an inside row (see Fig. 1). The discrimination is deduced from the results of the disruption of the large group when it was counted: none of the dispersed individuals came to join the members of the smaller group, but kept by themselves. Probably they later formed another group elsewhere composed of the

same individuals. One month after the smaller group was partially disturbed, it again had about the same number it had had originally, including the one individual marked with an unfamiliar color.

It is our opinion that *Smyrna karwinskii* adults have acquired this unusual social behavior as an adaptation tending to minimize the losses of individuals through the dry season resulting from predation on the one hand and excessive activity on the other, and to maximize the chances of early egg production when conditions are favorable for the dispersal of the species. This adaptive strategy nevertheless seems to be disadvantageous when compared with the one adopted by *S. blomfieldia datis*, whose larval polymorphism seems to indicate a more flexible ability to adapt itself to adverse ambient conditions.

ACKNOWLEDGMENTS

We are greatly indebted to Dr. Alexander B. Klots of the American Museum of Natural History, who besides encouraging the authors to publish the results of their observations, took time out of his busy schedule to read the manuscript and give much valuable criticism. We also thank Dr. Allen M. Young who shared important information with us, Viktor Hellebuyck who helped the authors in parts of their observations, and the rest of the family Muyshondt for their sustained efforts in the study of the Salvadorian butterflies.

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VARIATION OF *EREBIA CALLIAS* (SATYRIDAE) IN THE UNITED STATES¹

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Erebia callias Edwards is found in Asia (Iran, Mongolia), Siberia, and the Rocky Mountains of the United States. It is closely allied to *Erebia tyndarus* (Esper) of the Old World, with which it was thought to be conspecific, until de Lesse (1955) demonstrated that the two species have different numbers of chromosomes. The diploid number for *callias* is 30 and for *tyndarus*, 20.

This butterfly is not well known to collectors in the United States, probably because of its restricted habitat. It flies in the treeless Arctic-Alpine Zone above 10,000'. It is usually found in grassy areas, but I have also taken it on rocky outcroppings and flying about gravel patches. Several collectors have observed *callias* virtually swarming on Guanella Pass, Clear Creek Co., Colorado (observed by J. D. Eff in 1962, C. D. Ferris in 1967, and by O. Otto in 1972 as reported in the News of the Lepid. Soc., 15 March, 1973, p. 8).

Distribution

Holland (1898) reported *callias* from Colorado and New Mexico. Warren (1936) listed the same areas in North America. Ehrlich & Ehrlich (1961) list Colorado and Wyoming. Callaghan & Tidwell (1971) give Utah records. At the present time, *callias* is known from four states. The county records are listed below and state localities are shown in Fig. 1.

Colorado: Chafee, Clear Creek, Grand, Hinsdale, Lake, Larimer, Park, Summit (Brown et al., 1957; C. J. Durden, in litt., 1973).

Montana: Carbon (collected by author).

Utah: Summit, Uintah (Callaghan & Tidwell, 1971).

Wyoming: Fremont, Park, Sublette (Ferris, 1971).

A search of the major U.S. museum collections has failed to turn up any specimens from New Mexico. It is quite possible that *callias* occurs in the high mountains of the northern part of that state. Holland may

¹ Published with the approval of the Director, Wyoming Agricultural Experiment Station, as Journal Article JA 624.

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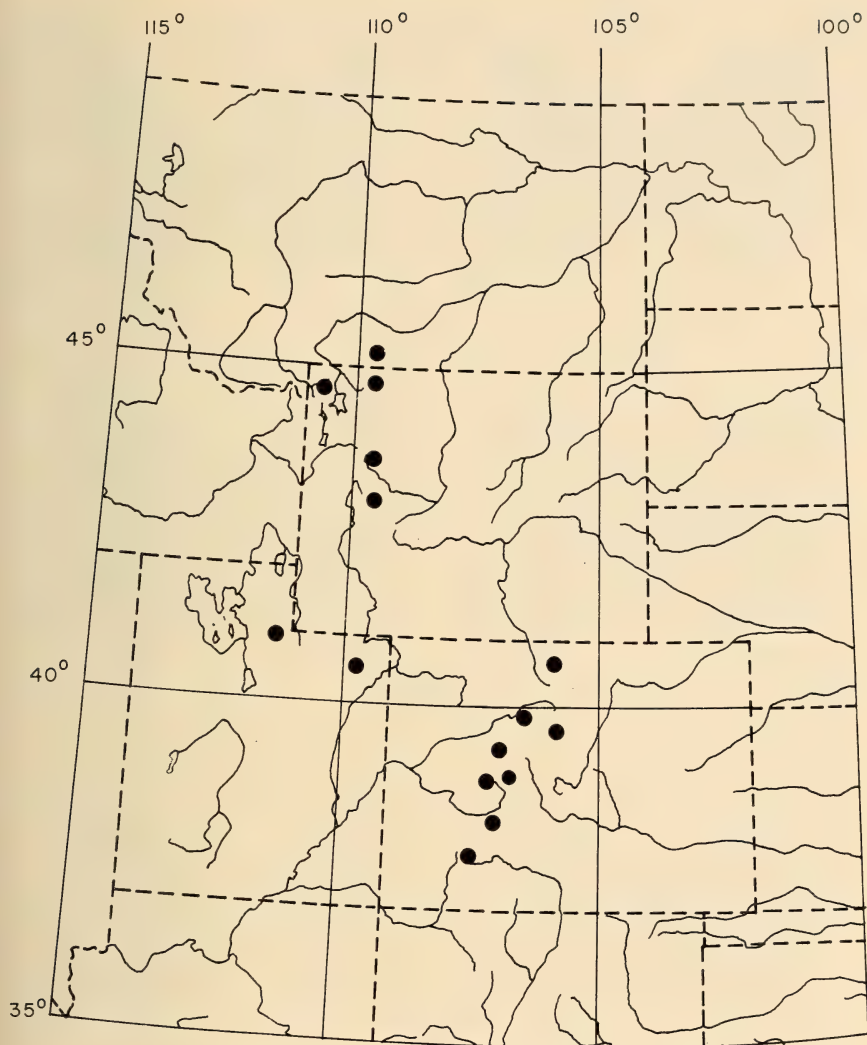


Fig. 1. Collection sites (black dots) for *E. callias* in North America.

have had specimens which are now lost, or he may have projected the range into New Mexico based upon the distribution in Colorado.

One would also expect to find *callias* in the Snowy Range Mountains of Wyoming (Albany and Carbon Cos.) as what appears to be suitable habitat exists. To date, the insect has not been collected in this area. This is a strange situation as *callias* is abundant in spots to the north

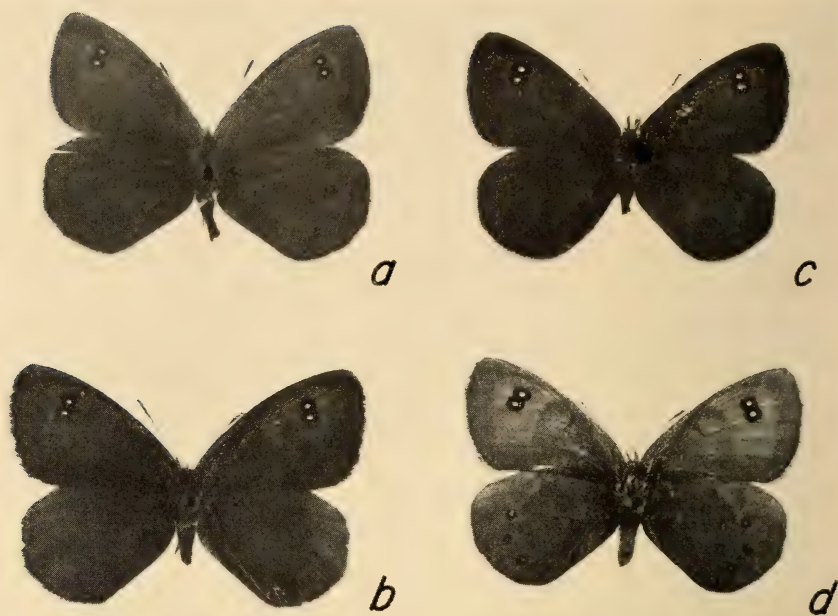


Fig. 2. "Normal" forms of *E. callias*: (a) ♂ Palmer Lake, 10,800', Sublette Co., Wyoming, 1 August 1972, genitalia Fig. 4 (b); (b), (c) ♂♂, and (d) ♀, Guanella Pass, 11,665', Clear Creek Co., Colorado, 11 August 1968.

and south of this area. Other alpine species normally associated with *callias* habitat, such as *Colias meadii* Edwards and *Parnassius phoebus* ssp., are found in the Snowy Range.

It seems strange that *callias* has not been reported from Canada or Alaska, since it occurs in Siberia. Perhaps it will turn up as more regions open to travel. It flies late in the season (early August) as alpine species go, when many of the other high altitude species have either ceased flying or are on the wane, and for this reason, may have been overlooked in some areas.

Variation

Fig. 2 illustrates three normal males and 1 female of *E. callias*. The two FW ocelli are fully developed and there is a HW submarginal row of three ocelli. Normally the FW ocelli are well-pupiled, while the HW ocelli vary in pupil size. This is the usual form found in Colorado, Utah, and central Wyoming.

Fig. 3 illustrates the variation in *callias* that occurs along the Montana-

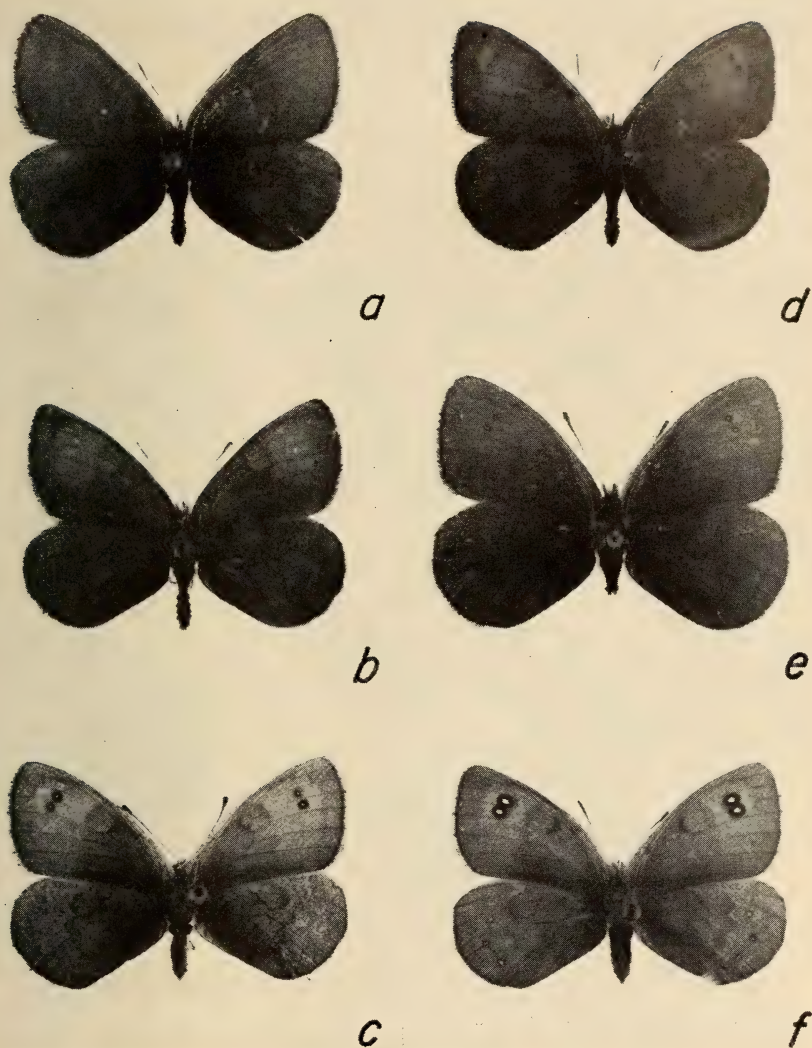


Fig. 3. *E. callias* from Beartooth Pass area, U.S. Hwy. 212, Carbon Co., Montana, 4,5 August 1972: (a,b,d,e) ♂♂; (c), (f) ♀♀. Some ♀♀ lack ocelli entirely. Genitalia of (e) in Fig. 4 (a).

Wyoming border on the Beartooth Plateau. "Normal" forms are found, but the majority of the specimens collected from this region are atypical when compared with Colorado material (Type Locality: Mosquito Pass, Park Co., Colorado).



Fig. 4. Genitalia: (a) ♂ shown in Fig. 3 (e); (b) ♂ shown in Fig. 2 (a); (c) ♂ from Beartooth Pass area, Carbon Co., Montana, 5 August 1972; (d)–(f), Guanella Pass, Clear Creek Co., Colorado, 11 August 1968.

With respect to the dorsal wing surfaces, all ocelli are absent in the extreme case, and only a fulvous patch appears on the FW. In most of the specimens, the HW ocelli are lacking. Only the pupils occur in other examples (FW) and the surrounding dark iris is absent. Other specimens exhibit FW ocelli that are substantially diminished in

size, and in some cases, the pupils are reduced to the point of obsolescence. Although subspecific names have been applied to *E. callias* in the Old World, it does not appear reasonable to propose another taxon for the Beartooth Plateau segregate. *E. callias* is a highly variable insect in both facies (Figs. 2, 3), and in genitalia (Fig. 4). There is no firm character, other than geography, upon which to erect a new taxon. B. C. S. Warren (pers. comm.) concurs in this matter. Warren (1936, p. 303) has also commented on the genitalic variation in the Old World races, and has identified two clasper types.

No explanation is offered regarding the variation in the U.S. populations. A parallel situation occurs with *E. tyndarus* in Europe and the non-ocellated form was described by Westwood (1851) as an aberrant *vesagus*. The *vesagus* form of *tyndarus* occurs locally as a form and in "normal" populations of *tyndarus* infrequently as an aberrant. In facies, *tyndarus f. vesagus* is identical with the Beartooth Plateau non-ocellated *E. callias*. Warren (1936) figures French material of *vesagus* (Plate 89). Perhaps the form name *vesagus* could be applied to Wyoming-Montana *callias*, but infrasubspecific names have no standing in the I. C. Z. N. Code.

ACKNOWLEDGMENTS

The author would like to thank the following for supplying information about *E. callias* in North America: Julian P. Donahue, Los Angeles County Museum of Natural History, Los Angeles, California; C. J. Durden, Texas Memorial Museum, Austin, Texas; Patrick J. Conway, Chicago, Illinois (for checking the Chicago Field Museum collection); Harry K. Clench, Carnegie Museum, Pittsburgh, Pennsylvania; Dr. Frederick H. Rindge, American Museum of Natural History, New York, New York; Dr. Edwin M. Perkins, Jr., University of Southern California, Los Angeles, California; Mike Toliver, Albuquerque, New Mexico; B. C. S. Warren, Folkestone, England.

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"ATTACKS" BY *POLYGONIA INTERROGATIONIS* (NYMPHALIDAE)
ON CHIMNEY SWIFTS AND INSECTS

Re-reading a note by Pyle (1972, J. Lepid. Soc. 26: 261) on a Lorquin's Admiral (*Limenitis lorquini burrisonii* Maynard) that chased after a Glaucous-winged Gull brought to mind some observations I made this past summer in Bartlesville, Washington County, Oklahoma on bird and insect-chasing by *Polygonia interrogationis* (Fabricius).

On 8 July 1973 I was exploring a field that contained a few trees surrounding a small marsh. Chimney Swifts (*Chaetura pelagica*) were often observed hunting over this area, sometimes making passes within 6 ft. of the ground surface. When a swift passed near a particular tree I noticed a butterfly in pursuit for some 20-30 ft. before breaking off with the chase. The butterfly, a male Question Mark, then returned to the tree and began a methodical patrol of one section of the tree, flying back and forth in front of it with periodic darts and chases after other flying insects including beetles, dragonflies, and other butterflies. I sat down next to the tree and decided to observe the butterfly's behavior, when another swift flew by. The Question Mark immediately took pursuit as before. After a brief chase the butterfly returned to the tree and resumed its patrolling. I was able to observe this behavior for several days but only in the evenings after 1800 hrs. At this time the butterflies were out patrolling and the Chimney Swifts were hunting over the field and marsh.

Pyle suggested that the chasing behavior exhibited by his Lorquin's Admiral was most likely a courtship chase, presumably the pursuit of a possible female. This possibly applies to the Question Mark since any flying object was pursued until it was apparently recognized. Another possibility is that these animals are exhibiting aggressive territorial behavior and are attacking all flying intruders. I observed some prolonged chases by two of the Question Marks in which they flew head-on at each other and beat the opponents wings with their own. Usually, however, one would make a "sneak attack" on the other and pursue it from the rear until it either chased the first temporarily away or was out-maneuvered. A third possibility would be a combination of the first two in which the butterfly leaves its post in pursuit of a possible female. When the butterfly identifies the object it either ceases pursuit or continues after in either an aggressive attack or a courtship chase.

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BIENNIALISM IN *OENEIS MACOUNII* (SATYRIDAE)

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Biennialism in insects is that situation where the insects life-cycle takes two years to complete and imagoes are produced but once every two years. It may be accompanied by biennial-flights, when in a given locality adults fly only in alternate years, or it may be accompanied by annual-flights. Unless biennial-flights are involved, biennialism is very difficult to perceive in nature without carefully working out the life-histories. Annual-flights may occur when the species is only partially biennial or when two allochronic populations are involved.

Many species of butterflies occurring in desert or near-desert regions are partially biennial. *Papilio rudkini* Comstock (Papilionidae), for example, is normally annual, but in especially dry seasons a portion of the population will remain in the pupal stage for an extra year before emerging. This is undoubtedly an advantage to the species as it reduces the risk of having an entire population wiped out in a particularly bad drought year.

Recognized cases of regular biennialism, however, are very rare in Lepidoptera and they are confined to species (almost exclusively Satyridae) that occur in arctic, alpine or at least boreal regions; suggesting that biennialism may be their means of coping with very short growing seasons. In the Palearctic Region, species with proven biennialism are restricted to *Oeneis jutta* (Hubner) and several species of *Erebia*, including *Erebia claudina* (Borkhausen) and *Erebia ligea* (Linnaeus); although a large number of *Erebia* and several other *Oeneis* are suspect. In the Nearctic Region, five species of the genus *Oeneis* (*jutta*, *macounii* (Edwards), *nevadensis* (Felder & Felder), *chryxus* (Double-day) and *taygete* Geyer) are known to be biennial in at least part of their ranges; several other species, including *Erebia disa* (Thunberg) (Masters, 1969), *Erebia theano* (Tauscher) (Masters, 1971) and *Boloria polaris* (Boisduval) (Nymphalidae) (Masters, 1971), are highly suspect.

The best known example of polyennialism in insects is the "Periodical Cicada" or "Seventeen-Year Locust," *Magicicada septendecim* (Linnaeus) (Homoptera), which has a seventeen-year life-cycle that produces adult insects once every seventeen years. Quite a few "broods" of *M. septendecim* are recognized, however, with each brood occupying a restricted geographical area distinctly different from other broods, and

with each brood making its emergences as imagos on its own seventeen-year cycle.

Biennialism does not produce a picture nearly as complex as septen-decennialism. However, in the genus *Oeneis* biennialism is usually accompanied by geographic brood territories. In most cases populations over extensive areas are on the same brood-cycle and alternation with another completely allopatric population on the alternate brood-cycle occurs only across a natural barrier such as a mountain range or desert. In *Oeneis* (e.g. *Oeneis jutta*) the areas of biennial alternation frequently correspond to areas inhabited by different subspecies; these subspecies are both allopatric and allochronic. When two biennial species of *Oeneis* inhabit the same region, although not necessarily the same habitat, they invariably alternate with each other and display very pronounced biennialism. In the genus *Erebia*, biennialism results in biennial flights in which nearby colonies randomly alternate with each other on the year of flight.

The types of *O. macounii* were collected at Nipigon, Ontario by Professor John Macoun in June 1884. The new species created quite a bit of interest and a number of persons journeyed to Nipigon to collect it, but with very mixed success. James Fletcher sought it in 1886, but got there in August and was too late for it, and again in 1887 which is the off year at Nipigon. Fletcher returned to Nipigon in 1888 with Samuel Scudder and was finally successful in getting it on July 5th. Fletcher wrote (1888) "I had been to Nepigon [sic! Nipigon] once before at exactly the right season and again a month later, but had not seen a specimen, and had begun to think that perhaps after all there might possibly be some mistake about the locality." *Oeneis macounii* was not taken for several more years at Nipigon, but Alberta specimens turned up and interest gradually diminished in the Nipigon colony.

As late as 1942, biennialism by *Oeneis macounii* was still not suspect. George Shirley Brooks had a summer cabin at Victoria Beach, Manitoba where he for years collected large numbers of *O. macounii* for exchange or sale. He wrote (1942) "*Oeneis macouni* [sic! *macounii*] Edw. has been taken only in a limited area at Victoria Beach where it flies at irregular periods among *Pinus banksiana*. One year it may be abundant, and then it may be abundant, and then it may not be seen for several years." Since all of Brooks specimens were taken in even-numbered years, it is surprising that he did not tumble onto the biennialism in this species—he collected it over a twenty year period at Victoria Beach.

The fact that *Oeneis macounii* is biennial was well known by the 1960's,

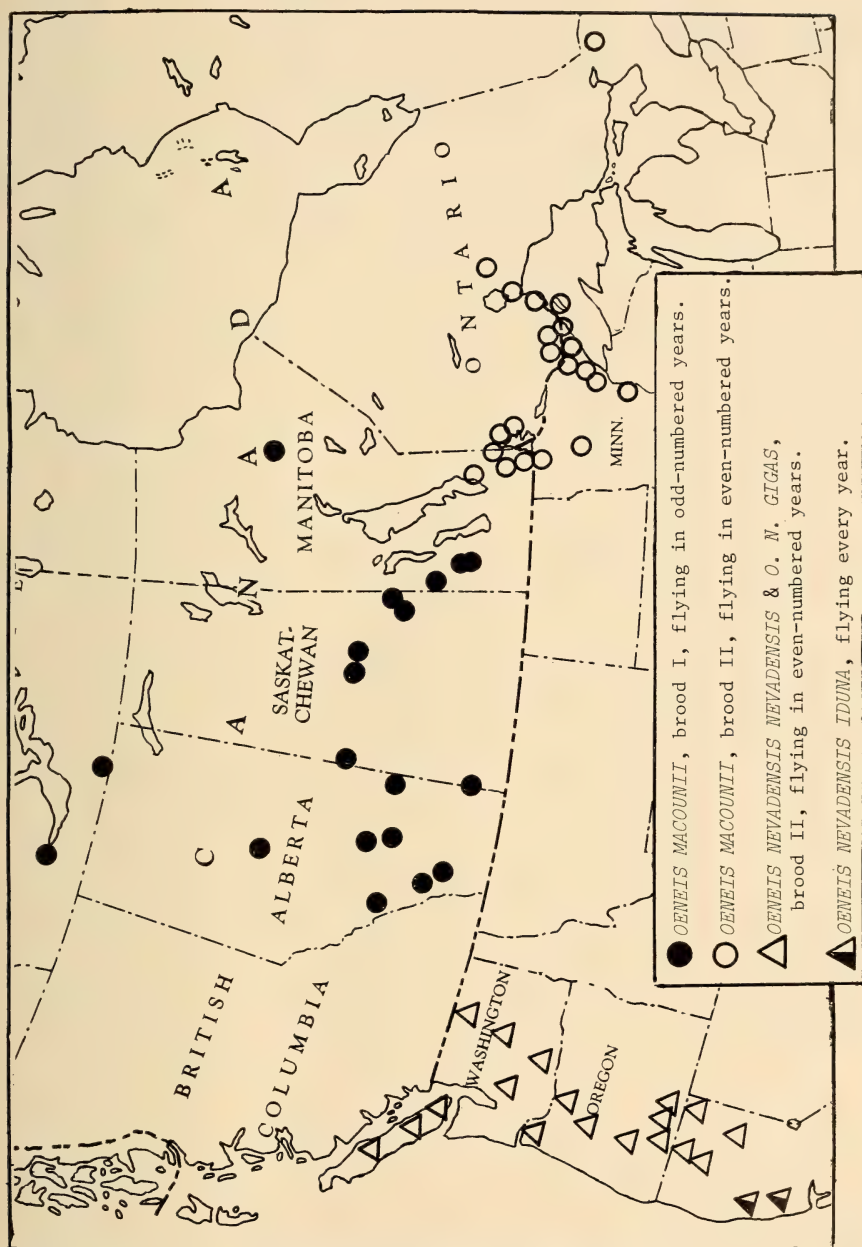


Fig. 1. Ranges of *Oeneis macounii* and *Oeneis nevadensis*, illustrating biennial flights and "brood territories."

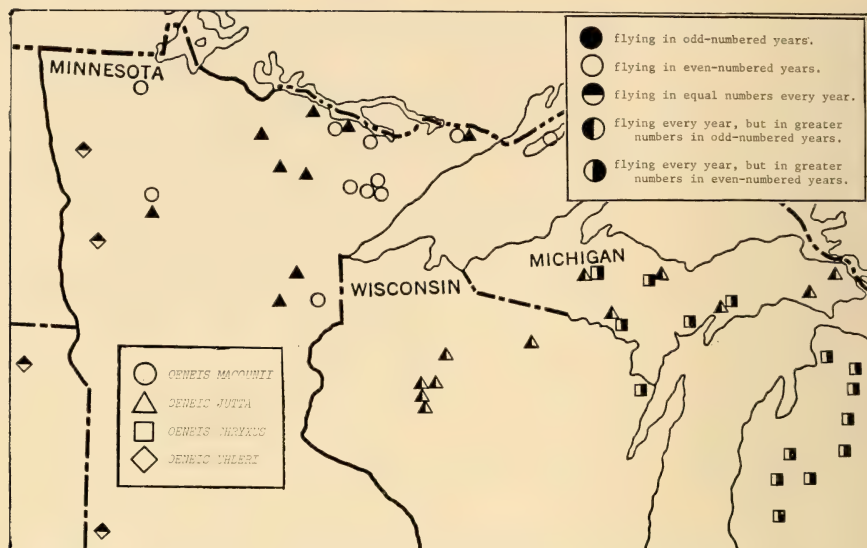


Fig. 2. Distribution of the genus *Oeneis* in Minnesota, Wisconsin and Michigan, illustrating alternation of annual flights.

but the first published record was by Masters, Sorenson & Conway (1967). C. S. Quelch first pointed out to me in 1966 that *O. macounii* colonies in Eastern Manitoba were on even-year cycles while those in Western Manitoba were on odd-year cycles. Since that time I have been gathering distributional and chronological data for all *Oeneis* species in order to demonstrate the point.

In my map (Fig. 1) the known localities for *Oeneis macounii* and the closely related *Oeneis nevadensis* (Felder & Felder) are shown. It is readily apparent that three distinct "brood territories" exist. The break between *Oeneis nevadensis* and *O. macounii* is the Rocky Mountains. The break between the eastern, even-year brood and the western odd-year brood of *O. macounii* is Lake Winnipeg and the Red River Valley, which is the former location of Glacial Lake Agassiz. The southernmost localities for *Oeneis nevadensis* are for subspecies *iduna* (Edwards) which apparently flies annually. The allochronic eastern and western populations of *Oeneis macounii* have been isolated from each other at least 18,000 years, since before Lake Agassiz was formed in the late Pleistocene, however they exhibit no phenotypic distinctions that would warrant the designation of subspecies.

Oeneis jutta occurs through most of the range occupied by *Oeneis macounii* and is also a biennial species. The most remarkable circumstance about this is the fact that *O. jutta* has the most pronounced biennialism where it comes into the same range as *O. macounii* and it alternates years with *Oeneis macounii*. This can be seen in the map (Fig. 2) showing a portion of the area where the two species are sympatric. The same dividing line (Lake Winnipeg—Red River Valley) that divides the eastern and western populations of *Oeneis macounii*, separates an eastern odd-year cycled population (subspecies *ascerta* Masters & Sorensen) from a western even-year cycled population (subspecies *ridingiana* Chermock & Chermock). In Minnesota where both species occur together, *O. jutta* is religiously biennial and can be taken only in odd-numbered years. In Wisconsin, east of the range of *O. macounii*, *O. jutta* may be taken in any year but exhibits a very strong population "pulse" occurring in vastly greater numbers in odd-numbered years. The further east you go, which is more distant from the range of *O. macounii*, the weaker this pulse becomes.

It would be attractive to theorize that interspecific competition has created the alternation in the annual flights of these two species, but this does not seem likely. For one thing, the two species have completely different habitats; *O. jutta* occupies sphagnum-moss/black spruce bogs while *O. macounii* inhabits sandy ridges where jack pine grows. Both species are territorial and have very similar adult behavior, however. A thorough discussion of the bionomics of these two species is given by Masters & Sorenson (1969).

Other species of *Oeneis* that occur in the Lake Superior region include *Oeneis uhleri varuna* (Edwards) and *Oeneis chryxus strigulosa* McDunnough (Fig. 2). *O. uhleri* is a prairie inhabitant which apparently occurs every year in fairly equal numbers. *O. chryxus strigulosa* occurs southeast of the range of *O. macounii*, apparently having a habitat association with sedimentary rocks. *O. chryxus* flies every year in Michigan, but exhibits a strong "pulse" with much more pronounced flights in even-numbered years—thus alternating with *O. jutta*.

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PHYCIODES TEXANA (NYMPHALIDAE) IN CALIFORNIA

A collecting trip to the Providence Mountains of eastern San Bernardino County, California, on 18 May 1973, resulted in a surprise capture—a new state record. While hiking down the south fork of Bonanza King Mine Canyon, I spotted two little dark butterflies flying close to the streambed. Both were captured at 1530. Confirming my initial suspicions, they were two males of *Phyciodes texana* (Edwards). One was in fairly good condition, the other rather worn. The two captured specimens were the only *texana* sighted that afternoon. This appears to be the first recorded capture of this species in California. It was not figured in any of the older books on California butterflies. And it was not mentioned in the recently published book, *The Butterflies of Southern California* by Thomas C. Emmel and John F. Emmel (Los Angeles County Museum of Natural History and the Ward Ritchie Press).

Captures of Arizonan butterflies are not unusual in the mountains of eastern San Bernardino County. Although part of the Mojave Desert, the Providence Mountains, the Ivanpah Mountains, the New York Mountains and the Sacramento Mountains tend to resemble in fauna and flora the Sonoran Desert of southern Arizona. These ranges adjacent to the Colorado River Valley receive more rainfall than the lower portions of the Mojave Desert. And they have a rainfall distribution similar to the Sonoran Desert, with winter rains being supplemented by thunderstorms in the summer. It is not surprising, therefore, that we get occasional reports of *Phoebis sennae* (Linnaeus), *Phoebis agarithe* (Boisduval), *Colias caesonia* (Stoll), *Eurema mexicana* (Boisduval), *Limenitis bredowii eulalia* (Doubleday) and *Strymon columella* (Fabricius) from this region. Lepidopterists should be on the lookout for other Arizona butterflies straying into this area. This unique region may very well produce other new state records.

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TWO MOTH SPECIES (PERICOPIDAE AND
NOTODONTIDAE) NEW TO TEXAS AND
THE UNITED STATES¹

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Two species of moths representing two families are recorded here as new to the United States. Only reared examples are known for one of these species, the other is represented by a single field collected example. Neither species is known to be of any economic importance.

PERICOPIDAE

Gnophaela aequinoctialis (Walker)

Diopsis aequinoctialis Walker, 1854. List of Specimens of Lepidopterous insects in the Collection of the British Museum. Lepidoptera Heterocera. London. 2: 331. (TL: South America).

While collecting in Panther Canyon above Landa Park, New Braunfels, Comal County, Texas, W. W. McGuire took one female on 9 April 1972. This specimen



Fig. 1. *Gnophaela aequinoctialis* (Walker), ♀, dorsal view; New Braunfels, Texas. (W. W. McGuire). Wing expanse 52 mm (center of thorax to tip of FW \times 2).

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Figs. 2 & 3. *Elymiotis notodontoides* Walker, ♂, ♀ respectively, dorsal view; McAllen, Texas. (Roy O. Kendall). Wing expanse, ♂ 40 mm, ♀ 50 mm (center of thorax to tip of FW $\times 2$).

is now in the collection of André Blanchard of Houston, Texas who kindly photographed it for illustration (Fig. 1).

There are twenty-six examples of this species represented in the National Museum of Natural History, Washington, D.C., all from Mexico. Specific data

are: twenty-one, Popocatepetl Park [Puebla], Mexico, 8,000', June; one, Jalapa [Oaxaca], Mexico; one, Tehuacan [Puebla], Mexico; two, Mexico; one, Cuernavaca [Morelos], Mexico. No other data available. The nearest of these locations is about 900 air miles from where the U.S. specimen was taken.

NOTODONTIDAE

Elymiotis notodontoides Walker

Walker, F., 1857. List of Specimens of Lepidopterous Insects in the Collection of the British Museum. Lepidoptera Heterocera. London. 11: 609. Described from a single male from an unknown locality.

On 11 September 1972, the author collected 4 last instar larvae feeding on the foliage of *Malpighia glabra* L., Malpighiaceae, a native plant of the area, but in this instance growing as an ornamental at a motel in McAllen, Hidalgo County, Texas. Further examination disclosed 9 pupae and 8 empty pupal cases at the base of this small shrub. Pupation took place in loose cocoons constructed in dried leaves and debris. Two larvae, two pupae, and all empty pupal cases were preserved in alcohol. The two remaining larvae pupated 14 and 17 September; adults, both males, emerged 24 and 27 September. Other adults emerged, *ex pupae*: 18-IX-72 (♀), 19-IX (♂), 20-IX (1♂, 1♀), 21-IX (1♂, 1♀), and 22-IX (♂), for a total of 6♂, 3♀ including the two *ex larva*. A male and female are illustrated (Figs. 2 & 3).

The pair which emerged 20 September were found *in copula* about 0730. The female was kept alive for egg production. Eighteen eggs were found in the container 22 September, only two of which were deposited on the larval foodplant. All of these eggs were preserved. The female was fed and placed over a caged living larval foodplant in the laboratory garden. After returning from a field trip on 30 September, the female was not to be found. No doubt it had died and had been eaten by ants. Only two eggs could be found, and these on the foliage. Near the end of October, examination disclosed the eggs had not hatched. Assuming the eggs to be fertile, and pending further study, it would appear this species may have an ovum diapause.

Examples of this species from other locations in the National Museum of Natural History are: three, Paso San Juan, Veracruz, Mexico; one, Coatepec [Veracruz], Mexico; one, Tepic [Nayarit], Mexico, June; one, Cabezas nr. Cardel, Veracruz, Mexico, July; one, Cajuli Sbo Domingo; one ♂, Constanza, Dominican Republic, 2-6 June 1969, *leg.* Flint & Gomez; one ♀, Los Hidalgos, Dominican Republic, 4-5 June, *leg.* Flint & Gomez. This species has not been collected on the other islands of the Antilles by any of the N.M.N.H. recent collectors.

ACKNOWLEDGMENTS

I wish to thank Dr. E. L. Todd, Systematic Laboratory, U.S. Department of Agriculture, at the National Museum of Natural History, for determining these species, for providing data on like specimens in the national collection, and reference citations. I'm also indebted to André Blanchard for photographing the specimens illustrated.

URBANUS DORANTES DORANTES STOLL (HESPERIIDAE):
ANOTHER EXAMPLE OF FLORIDA'S
POPULATION EXPLOSION

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One hears so much about the population explosion in Florida, that it seems difficult to imagine at times how even a butterfly could survive it. Indeed, the drainage of the swamps, burning and bulldozing of forest lands, and increasing levels of pollution have gravely endangered many of Florida's unique species of Lepidoptera. In spite of this, certain other species are experiencing a 'population explosion' of their own.

One such species is *Urbanus dorantes dorantes* Stoll, which, prior to 1969, was not believed to be present in Florida. Kimball (1965) listed an old record from the Cleveland Museum, labeled Tampa, 1908, and Miami, 1916, but this was thought to be fraudulent. However, Clench (1970) discovered that the species was common at Chokoloskee (Collier County) on 20 November 1969. During March and April 1970, Miller & Miller (1970) took specimens at Homestead (Dade County), Key Largo, and Tavernier (Monroe County). Pliske (1971) reported that *U. dorantes dorantes* was common in Dade County from November 1969 through January 1970. Also, C. Hallas has reported specimens from Dade County in April and December 1971, and from Key Largo in January 1972. In addition, Burris (1973) took specimens in Hillsborough County during February and April 1972.

The first specimen of *U. dorantes dorantes* taken by the author was found in Pahokee (Palm Beach County) on 12 June 1971. Then, on 12 October 1972, *dorantes* was found to be common near Bartow (Polk County). A more careful search of more northerly areas revealed this hesperiid to be present in Gainesville (Alachua County) as well. *Urbanus proteus* L. was abundant at the time and it was estimated that *U. dorantes dorantes* comprised at least five percent of the tailed skippers seen in the Gainesville area. On 16 October 1972 several specimens were taken in Yulee (Nassau County) at blossoms of ironweed and *Trilisa* sp. along the roadside.

On 4 November 1972 *U. dorantes dorantes* was found to be common at Lake Worth (Palm Beach County), Homestead, and Key Largo. In these localities it was clearly the dominant tailed skipper. On Key

Largo a half acre field, overgrown with *Lantana* sp. and *Bidens pilosa* L., was estimated to contain about one hundred specimens of *dorantes* and only a few of *proteus*. The flight pattern of the two seemed to be quite similar, although *dorantes* was somewhat faster and less erratic than *proteus*. The absence of green iridescence in *dorantes* was not easily evident while on the wing, and the two species were best distinguished in the field by the difference in maculation of the underside of the hindwing. On upper Key Largo, *U. dorantes dorantes* could also be found along the roadside and on shaded trails through the tropical hardwood forest. Along the forest trails it was observed that the flight pattern of *dorantes* was remarkably similar to that of *Polygonus leo* (Gmelin), i.e., *dorantes* would dart back and forth between the dense vegetation on either side of the trail and finally alight on the underside of a leaf.

U. dorantes dorantes was again observed in the same localities in southern Florida during late November through December 1972, and on 18 December 1972 it was captured in Largo and Dunedin (Pinellas County). Subsequently the populations declined, although on 6 March 1973 *dorantes* was still present on Key Largo and was also found at Devils Gardens (Hendry County).

During October, November, and December 1972, a careful search was made for the larvae of *U. dorantes dorantes* on leguminous plants at various locations. These plants were: at Bartow, *Pueraria thunbergiana* (S. & Z.); at Lake Worth, *Vigna marina* Merrill; at Homestead, *Glycine max* L. and *Phaseolus lathyroides* L.; and at Key Largo, *Galactia spiciformis* Torr & Gray and *Desmodium tortuosum* DC. The plants were checked by hand and by the use of a D-Vac (back-pack suction machine). However no larvae of *dorantes* were found.

In summation, it appears that for the past three years *U. dorantes dorantes* has been common in southern Florida, with a peak abundance during November, December, and January. It also appears that in 1972 *dorantes* extended its range far northward along the coast and into the interior sections. All specimens taken in Florida belong to the subspecies *dorantes* (distinguishing characteristics may be found in Clench (1970)). This fact implies that *dorantes* was not an introduction from Cuba, as a distinct subspecies occurs there. However, *U. dorantes dorantes* is common in southeastern Texas ranging as far north as the Dallas area, and thus conceivably it could have reached Florida from a northern route, around the Gulf coast. If so, the records from 1908 and 1916 are perhaps valid after all. It seems incomprehensible, however, that *dorantes* could have been overlooked for fifty years, especially

in view of the extensive collecting in south Florida. One is also at a loss to explain the absence of *dorantes* along the northern Gulf coast.

The most logical explanation, Miller & Miller (1970), is that *dorantes* was introduced artificially into southern Florida, or possibly transported to the area by the winds of Hurricane Camille in August 1969. Because of its range in Texas, *dorantes* may well prove to be a late summer visitor throughout northern Florida and coastal Georgia.

ACKNOWLEDGMENTS

I wish to thank T. M. Neal for his assistance and many valuable observations. Also, I am grateful to L. D. Miller, H. V. Weems, C. P. Kimball, and C. Hallas for their observations, comments, and suggestions that led to this paper.

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BUTTERFLIES ATTRACTED TO AMBER GLASS

During the summer of 1973 I came across two instances of *Speyeria* spp. being attracted to the amber-colored glass used on the signal lights of motor vehicles.

The first instance involved my motorcycle. I had left the machine parked on a disused logging road on Mt. Sicker, Vancouver Island. I returned just in time to see a butterfly alight on one of the amber lights. On approaching I saw that it was quivering its wings rapidly in the manner often seen when a male butterfly has settled near a receptive female. Its attention was completely focused on the colored glass, and I netted it easily. It was a male *Speyeria hydaspe* Bdv.

In the second case a pickup truck was the attraction. It was parked near the summit of Mt. Prevost, the butterfly circled it several times, on each circuit dipping towards each of the little amber lights. This insect was quite wary, and I failed to collect it. It was a *Speyeria*, either *S. hydaspe* or *S. zerene*, as these are the only two species occurring in the vicinity.

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CONFIRMATION OF RHOPALOCERA (PIERIDAE,
NYMPHALIDAE) PREVIOUSLY RECORDED FOR TEXAS
AND THE UNITED STATES¹

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The object of this paper is to remove the dubious status of earlier reports of two species of Lepidoptera being found in Texas. Each species is represented at present by a single example only. Examples of earlier recordings have not been found; it is possible, however, that they do exist.

These species may represent single-brooded migrants which come to Texas from time to time. A precise judgment on this cannot be made until life history studies are conducted. Such studies would disclose critical ecological influences upon each. Another possible conclusion is that they are actually established in our fauna, but at such low population levels that they are seldom encountered by collectors. In any event, based on the good condition of these particular examples, we may conclude that they had not been on the wing long. No major climatic disturbances were involved.

Enantia melite (Linnaeus) 1763

Papilio melite Linnaeus, 1763. *Amoen. Acad.*, vol. 6, p. 403 (gives habitat as Indis).

Leptalis melite Linnaeus, 1767. *Syst. Nat.*, 775; Skinner, 1898, *A Syn. Catalogue of N. A. Rhopalocera*; Dyar, 1902, *A list of N. A. Lepidoptera* (gives distribution as Mexico, New Mexico).

Dismorphia melite: McDunnough, 1938, *Check List of Lepid. of Canada and the U.S.A.* (lists as doubtful N. A. occurrence); Holland, 1955, *The Butterfly Book* (credits to our fauna on the authority of Reakirt).

Licinia melite: Klots, 1951, *A field Guide to the Butterflies* (vaguely recorded from Texas).

Enantia melite: Ehrlich & Ehrlich, 1961, *How to Know the Butterflies* (may occasionally stray across our southern border); dos Passos, 1961, *J. Lepid. Soc.* 15: 211 (of doubtful occurrence in the Nearctic region).

One example of this species was collected 3 September 1972 by W. W. McGuire in Bentsen-Rio Grande Valley State Park, Hidalgo County, Texas. The specimen, illustrated in Fig. 1, is in McGuire's collection.

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Fig. 1. *Enantia melite* (Linnaeus), ♂, dorsal view; Hidalgo County, Texas. (W. W. McGuire). Wing expanse 54 mm (center thorax to tip FW \times 2).

Hamadryas amphinome mexicana (Lucas) 1853

Papilio amphinome Linnaeus, 1767. Syst. Nat. (X), i, p. 473, no. 95.

Hamadryas Hübner, 1806. Samml. Exot. Schmett. 1 pl. [47]; selected *Papilio amphinome* L. as the type species. Hemming, 1934, The Generic Names of the Holarctic Butterflies, vol. 1 (1758–1863), British Museum (N.H.), London, states that *Ageronia*, though valid nomenclatorially, is not required, as *chloë* Stoll, selected by Scudder as the type, is congeneric with *amphinome* L.; also, that *Peridromia*, also valid nomenclatorially, is not required as *arethusa* Cramer, selected by Scudder as the type, is congeneric with *amphinome* L., the type of *Hamadryas* Hb.

Peridromia mexicana Lucas, 1853. Revue et magasin de zoologie, p. 311–312 (TL: Mexico).

Ageronia amphinome mexicana (Lucas): Frustorfer, 1913, in Seitz, Gross-schmett. Ende 5: 543–544, gives distribution as Texas, Mexico, Guatemala, Honduras, Chiriqui.

Hamadryas amphinome mexicana: Monroe, Rose S., Garry N. Ross, and Roger N. Williams, J. Lepid. Soc. 21: 195, collected 2 ♂ at El Jaral, Honduras, 9 & 13 August 1962.

Although Frustorfer included Texas in the distribution for this subspecies, the name has never appeared on any check-list of Rhopalocera for the United States. In an attempt to locate other possible existing

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Fig. 2. *Hamadryas amphinome mexicana* (Lucas), ♂, dorsal (2A) and ventral (2B) views; Hidalgo County, Texas. (W. W. McGuire). Wing expanse 76 mm (center thorax to tip FW \times 2).



2A



2B

examples, several museums were contacted. In letter dated 24 August 1973, Dr. P. Viette, Museum National D'histoire Naturelle, Paris, informed the writer that the type series of *Peridromia mexicana* could not be found. A letter dated 11 October 1973 from Mr. P. R. Ackery of the British Museum (N.H.), London, advised that no examples of *mexicana* could be found in the collection from locations farther north than Mexico. Mr. William D. Field, National Museum of Natural History, Washington, D.C., advised in letter dated 23 February 1973 that he could find no examples in the national collection labeled *mexicana*.

One example of this subspecies was collected 3 September 1972 by W. W. McGuire in Bentsen-Rio Grande Valley State Park, Hidalgo County, Texas. The specimen, illustrated in Fig. 2, is in McGuire's collection.

ACKNOWLEDGMENTS

Special thanks are extended to Mr. André Blanchard and his wife May Elise for photographing the specimens illustrated. I also wish to thank Dr. P. Viette, Mr. P. R. Ackery, and Mr. William D. Field for checking the collections in their charge and for other valuable information.

PELLICIA COSTIMACULA HERRICH-SCHAFER IN THE UNITED STATES (HESPERIIDAE)

Klots (1951, A Field Guide To The Butterflies, Boston) listed *Pellicia costimacula* Herrich-Schaffer as occurring casually in the United States. In 1964, dos Passos (A Synonymic List of the Nearctic Rhopalocera) dropped *P. costimacula* from the United States list and substituted *P. angra* Evans, a superficially similar species that was undescribed at the time Klots was published.

I have taken fifteen male *Pellicia* in the Rio Grande Valley of Texas in the past six years. The genitalia of all correspond exactly to Evans' figure (1953, Catalog of the American HesperIIDae, London. Part III, pl. 33) of *P. costimacula arina* Evans. Therefore, this species should be returned to the United States list. I am advised by H. A. Freeman (pers. comm.) that there is good justification for considering *arina* to be a valid species, especially on the basis of genitalia.

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A PRELIMINARY CHECKLIST OF THE BUTTERFLIES
OF KENTUCKY¹

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Kentucky has been one of the more poorly studied states with regard to its insect fauna. Until recently very little had been published on the Lepidoptera of the "Bluegrass State," except for the many descriptions of new Microlepidoptera by V. T. Chambers of Covington (near Cincinnati, Ohio). The most recent state list of butterflies was that of Wheat (1908) [1909], which was poorly annotated and which included only 65 species. Before that, Hattie Warner published two nearly identical lists (1894, 1895), the first with 60 species and the second with 61. All three of these early lists were based on specimens in the collection of the Kentucky Agricultural Experiment Station, Lexington.

While Kentucky records are mentioned in various broader works on North American Lepidoptera, the state seems to be a blank on the distribution maps of most faunal and taxonomic publications. A few sources of information include more local coverages: Cook (1948) wrote of spring collecting in his area, and published the first record of *Erora laeta* from Kentucky. Merritt (1948) published the most exhaustive and complete list to that time, treating the fauna of Jefferson County (which includes Louisville). His work includes 63 species from that county, plus 6 more from within 100 miles. Records from an unpublished Master's thesis by D. K. Weniger (1946) augmented his own as source material. Covell (1969) provided a pre-impoundment list of one weekend's collecting in lowlands of Trigg Co. which are now beneath the waters of Lake Barkley.

Additional printed information is to be found in the mimeographed "Club Notes" of the now-defunct Moth and Butterfly Club, which existed from 1946 to 1955. H. O. Ladd of Elizabethtown and James Unseld of Gravel Switch included some reports of Kentucky butterflies they had observed and collected. Finally, one may consult reports in the Field Season Summary of the Lepidopterists' Society for the years 1948-1952 and 1959-1972 (except 1962). Major contributors to these summaries include Carl Cook, James R. Merritt, Burt L. Monroe, Jr., Ralph Beebe, J. B. Wood, and myself.

Since arriving at the University of Louisville in 1964, one of my projects

¹ University of Louisville Contributions in Biology No. 165 (New Series).

has been to prepare a thorough annotated checklist of all Kentucky Lepidoptera. So far, of the more than 1350 species recorded from the "Bluegrass State" in my card file, only 123 are butterflies. It is the purpose of this paper to make known the species I know to have been collected or observed in Kentucky, with hopes that those who know of additions to this list will help extend the number by submitting their records. The broader work will hopefully be ready for publication in the next year or so.

Another reason for publishing a butterfly list at this time is to end the confusion caused in the past by my circulating ditto-reproduced lists, occasionally revised, for the purpose of informing my colleagues of the known Kentucky butterflies. Some workers are desirous of having a published, up-to-date list to aid them in their revisionary and faunal studies of specific butterfly groups.

Although the contributions of recent collectors in Kentucky will be included in the larger study in preparation in connection with the new records for which they are responsible, I would like to thank the following for their cooperation in making this list possible: William R. Black, Jr., Annette F. Braun, Carl Cook, Carl C. Cornett, Charles V. Covell III, Charles J. Dempwolf, James K. Ettman, Greg Florence, Loran D. Gibson, Robert V. Gregg, James Harrod, Richard Henderson, L. C. Koehn, H. O. Ladd, James R. Merritt, Burt L. Monroe, Jr., Siegfried Scholz, J. A. Shields, James Tuttle, and J. B. and Lark Lynne Wood.

Nomenclature used here follows the 1964 dos Passos *Synonymic List of the Nearctic Rhopalocera* and its two later partial revisions, with a few other changes reflecting more recent articles changing nomenclature and taxonomic status (as with *Lethe* species, and the use of *Cynthia*). The only annotation used here is the asterisk placed before the names of species for which I have only one or two records, or for which there seem to be acceptable sight records. While data on any species of Kentucky butterflies will be most welcome, I would especially like to hear of captures of species either missing from the list, or indicated with the asterisk.

SUPERFAMILY HESPERIOIDEA

Family Hesperidae

<i>Ambliscirtes samoset</i> (Scudder)	* <i>Poanes viator</i> (Edwards)
<i>Ambliscirtes aesculapius</i> (Fabricius)	<i>Atrytone delaware</i> (Edwards)
<i>Ambliscirtes vialis</i> (Edwards)	<i>Atalopedes campestris</i> (Boisduval)
* <i>Atrytonopsis hianna</i> (Scudder)	<i>Pompeius verna</i> (Edwards)
<i>Euphyes vestris metacomet</i> (Harris)	<i>Wallengrenia otho egeremet</i> (Scudder)
<i>Poanes hobomok</i> (Harris)	<i>Polites coras</i> (Cramer)
<i>Poanes zabulon</i> (Boisduval and LeConte)	<i>Polites themistocles</i> (Latreille)

- Polites origenes* (Fabricius)
 **Hesperia metea* Scudder
Hesperia leonardus Harris
Hylephila phyleus (Drury)
Thymelicus lineola (Ochsenheimer)
Ancyloxypha numitor (Fabricius)
Lerema accius (Smith)
Nastra therminier (Latreille)
Pholisora catullus (Fabricius)
Pyrgus communis (Grote)
Erynnis icelus (Scudder and Burgess)
Erynnis brizo (Boisduval and LeConte)
 **Erynnis baptisiae* (Forbes)
 **Erynnis zarucco* (Lucas)
- **Erynnis funeralis* (Scudder and Burgess)
Erynnis martialis (Scudder)
Erynnis horatius (Scudder and Burgess)
Erynnis juvenalis (Fabricius)
Staphylus mazans hayhurstii (Edwards)
Thorybes bathyllus (Smith)
Thorybes pylades (Scudder)
Thorybes confusus Bell
Achalarus lyciades (Geyer)
Autochthon cellus (Boisduval and LeConte)
 **Urbanus proteus* (Linnaeus)
Epargyreus clarus (Cramer)

SUPERFAMILY PAPILIONOIDEA

Family Papilionidae

- Battus philenor* (Linnaeus)
 **Battus polydamas* (Linnaeus)
Papilio polyxenes asterias Stoll
Papilio cresphontes Cramer
- Papilio glaucus* Linnaeus
Papilio troilus Linnaeus
 **Papilio palamedes* Drury
Graphium marcellus (Cramer)

Family Pieridae

- Pieris protodice* Boisduval and LeConte
 **Pieris virginiensis* Edwards
Pieris rapae (Linnaeus)
Colias eurytheme Boisduval
Colias philodice Godart
Colias cesonia (Stoll)
Phoebis sennae eubule (Linnaeus)
 **Kricogonia lyside* (Godart)
- Eurema lisa* Boisduval and LeConte
Eurema nicippe (Cramer)
Nathalis iole Boisduval
Anthocaris midea Hübner
Euchloe olympia (Edwards)

Family Riodinidae

- Calephelis borealis* (Grote and Robinson)

Family Lycaenidae

- Harkenclenus titus mopsus* (Hübner)
Satyrrium liparops strigosa (Harris)
Satyrrium calanus falacer (Godart)
 **Satyrrium caryaevorus* (McDunnough)
Satyrrium edwardsii (Saunders)
Satyrrium acadia (Edwards)
Calycopis cecrops (Fabricius)
 **Callophrys irus* (Godart)
Callophrys henrici (Grote and Robinson)
Callophrys augustinus croesiodes Scudder
Callophrys niphon (Hübner)
Callophrys gryneus (Hübner)
Atlides halesus (Cramer)
- **Eurystrymon ontario* (Edwards)
Panthiades m-album (Boisduval and LeConte)
Strymon melinus Hübner
 **Erora laeta* (Edwards)
Feniseca tarquinius (Fabricius)
Lycaena thoe (Guerin-Meneville)
Lycaena phlaeas americana Harris
Everes comyntas (Godart)
Glaucopsyche lygdamus (Doubleday)
Celastrina argiolus pseudargiolus (Boisduval and LeConte)

Family Libytheidae

Libytheana bachmanii (Kirtland)

Family Nymphalidae

- | | |
|---|--|
| <i>Anaea andria</i> Scudder | <i>Polygonia interrogationis</i> (Fabricius) |
| <i>Asterocampa celtis</i> (Boisduval and Le-Conte) | <i>Polygonia comma</i> (Harris) |
| <i>Asterocampa clyton</i> (Boisduval and Le-Conte) | * <i>Polygonia faunus</i> (Edwards) |
| * <i>Limenitis arthemis arthemis</i> (Drury) | <i>Polygonia progne</i> (Cramer) |
| <i>Limenitis arthemis astyanax</i> (Fabricius) | <i>Chlosyne nycteis</i> (Doubleday) |
| <i>Limenitis archippus</i> (Cramer) | * <i>Chlosyne gorgone</i> (Hübner) |
| * <i>Anartia jatrophae</i> (Johansson) | * <i>Chlosyne harrisii</i> (Scudder) |
| <i>Vanessa atalanta</i> (Linnaeus) | <i>Phyciodes tharos</i> (Drury) |
| <i>Cynthia virginicensis</i> (Drury) | <i>Euphydryas phaeton</i> (Drury) |
| <i>Cynthia cardui</i> (Linnaeus) | <i>Boloria toddi</i> (Holland) |
| <i>Junonia coenia</i> (Hübner) | <i>Speyeria idalia</i> (Drury) |
| * <i>Nymphalis vaughaniana</i> (Denis and Schiffermüller) | <i>Speyeria diana</i> (Cramer) |
| <i>Nymphalis milberti</i> (Godart) | <i>Speyeria cybele</i> (Fabricius) |
| <i>Nymphalis antiopa</i> (Linnaeus) | * <i>Speyeria aphrodite</i> (Fabricius) |
| | <i>Euptoieta claudia</i> (Cramer) |
| | <i>Agraulis vanillae</i> (Linnaeus) |

Family Danaidae

Danaus plexippus (Linnaeus)

Family Satyridae

- | | |
|----------------------------------|--|
| <i>Lethe anthedon</i> (Clark) | <i>Euptychia hermes sosybius</i> (Fabricius) |
| * <i>Lethe creola</i> (Skinner) | <i>Euptychia cymela</i> (Cramer) |
| <i>Lethe appalachia</i> Chernock | <i>Cercyonis pegala</i> (Fabricius) |
| <i>Euptychia gemma</i> (Hübner) | |

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NOTES ON THE BIOLOGY OF *PTERONYMIA NOTILLA*
(ITHOMIIDAE) IN A COSTA RICAN MOUNTAIN FOREST

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This report is one of a series of descriptive papers on the biology of species of ithomiid butterflies sympatric in one mountainous region of Costa Rica. It deals with the biology of *Pteronymia notilla* Butler & Druce. While a substantial amount of information is available on the taxonomy and phylogeny of the Central American Ithomiidae (Fox, 1968), my reports (Young, 1972a,b) emphasize: (1) description of immature stages, (2) larval foodplant records, and (3) selected behavior patterns of larvae and adults. The eventual goal of these seemingly unrelated studies of different genera and species in the Ithomiidae is to describe the ecological and behavioral mechanisms that account for the observed local species diversity and structure of the ithomiid community at the single locality selected for study. While we are a long way from this synthesis, the present paper includes the kinds of information on life history that will provide the foundation for interpretation of community structure. Inherent in this approach to the community ecology of tropical butterflies is the conviction that local community structure in these organisms is determined to a large extent by generic and species differences in adult reproductive behavior and larval foodplant selectivity.

METHODS

The selected locality is known as "Cuesta Angel" and is located on the Caribbean side of the Central Cordillera that runs through Costa Rica. The locality is about 8 km from Cariblanco (Heredia Province) and the specific area under study is one slope of a 300-meter deep forest-covered ravine (Fig. 1) whose bottom is the Rio Sarapiquí. The ridge-top elevation of the ravine is about 1000 m above sea level with persistent cloud cover (Fig. 1) and the general region is montane tropical forest or cloud forest. The ithomiine fauna is rich in both the forest understory and second-growth patches that are most abundant along a roadcut (the road to Puerto Viejo), which runs about 10 m from the ridge-top of the slope selected for study. Several genera of ithomiines, including *Dircenna*, *Godyris*, *Oleria*, *Hymenitis*, and *Pseudoscada* (in addition to *Pteronymia*) can be found both in river-bottom forest as well as ridge-top forest and second-growth. The river-bottom forest



Fig. 1. The ravine at Cuesta Angel along the Central Cordillera in Costa Rica, where field studies of *Pteronymia notilla* were conducted. The butterfly is abundant in the understory of the forest down the sides of the ravine, and also along the edges of cleared second-growth (foreground and opposite ridge-top) associated with a roadcut.

is easily accessible via a small rock road that winds down the slope from the roadcut, and eventually goes up the opposite side of the ravine to the second ridge-top, where a small farming colony is located (see the cleared area on top of the opposite side of the ravine in Fig. 1). Other areas along the slope of the ravine are accessible with the use of rope and harness to work down the mountain side between roadcuts.

Most of the field observations on adults and immatures of *P. notilla* were made at the river-bottom; here, studies were confined to a strip of very dense forest understory bordering the bank of the Rio Sarapiquí. The same area of river-bottom forest has been the study site for similar studies on the biology of *Itaballia caesia* (Pieridae) (Young, 1972c), the ithomiine *Hymenitis nero* (Young, 1972a), and the nymphalid *Victorina epaphus* (Young, 1972e). This area was visited a total of 10

days during July and August of 1971 for the sole purpose of studying *P. notilla*. Usually no more than 3 to 4 hours during the morning were spent here each day.

During July 1972, we found a thin strip of clearing that ran up the slope of the ravine at a point further west of this river-bottom site, and very close to a second wooden bridge (the one not having a waterfall near it) at a hairpin turn in the road to Puerto Viejo. The clearing was made by the I. C. E. (Instituto Costarricense de Electricidad) during the installation of a telegraph line across the Rio Sarapiquí; the vegetation under the line is cut down at least twice annually. Here we searched a total of five days for eggs, larvae, and foodplants of *P. notilla*, within the dense understory immediately to either side of this strip, and within the thinned-out vegetation of the strip itself. We worked a distance of about 100 m, from river-bottom to the road on top, spending about three hours each day doing only this work. Although the butterfly was seen frequently in the second-growth along the roadcut near the ridge-top, we did not make any attempts to study it there.

Field studies of *P. notilla* included observations of habitat selection by flying adults, observations on oviposition behavior, determinations of larval foodplants, and note-taking on larval behavior. All of these studies were conducted each day we visited the river-bottom at Cuesta Angel.

Laboratory studies consisted of describing life stages and estimating mean developmental time from egg to adult. The "laboratory" was a converted tool shed on the premises of the Costa Rican program of the Associated Colleges of the Midwest in San Jose, Costa Rica. Eggs were collected in the field at Cuesta Angel and transported by jeep to San Jose within one or two days. The eggs were confined to clear plastic bags (each one 8×20 cm) containing fresh cuttings of the foodplant. We inspected immatures every one to three days, measuring body length of larvae, collecting head capsules, and examining color patterns. A total of 25 eggs were collected for these studies, all within a three day period, and divided into five laboratory cultures each containing five eggs. The 25 eggs represent a total of seven oviposition sequences in the river-bottom study area. Probably several different females were involved in the egg-laying, so that genetic differences may be a source of variability in estimating developmental time.

Laboratory conditions were $21-23^{\circ}$ C and 40-60% humidity for the 35-day rearing period in San Jose. The cultures were kept on a table in a shaded part of the shed. Foodplant was replenished every 3-4 days and bags were wiped clean of excess moisture and feces. The same techniques have proven successful for rearing immature stages of several

different groups of tropical butterflies with minimal mortality (Young, 1972a, b, c, d, e, f; Young & Muyshondt, 1972, 1973).

RESULTS

Habitat and larval foodplant. The butterfly (Fig. 2,A) is found throughout the slopes of the ravine, but adults are more abundant in shaded forest understory, especially where it borders thinned-out areas of second-growth. The uniform abundance of the butterfly at various points on the side of the ravine indicates that the species is not responding to any gradients in micro-environmental factors. But a difference in larval foodplants exists between the river-bottom and higher places within forest understory on the side of the ravine: the single larval foodplant found at the river-bottom is *Cestrum megalophyllum* Dum. in the Solanaceae. Here, the plant occurs as a small woody understory tree that grows to about 3 m in height. The tree can often be found growing in small groups of 2-5 individuals, although these groups are patchily-distributed in the understory. The uppersides of the very large conspicuous leaves of this species are often covered with moss and other forms of epiphytic growth.

Further up the side of the ravine, another larval foodplant is an unidentified species of *Capsicum*, also a member of the Solanaceae. This species represents another small woody member of the understory. But along the cleared strip of vegetation made by the I.C.E., there are extensive growths of suckers from the cut-down trunks of the original trees. The leaves of these suckers are generally larger than those of the original trees and often much lighter green in color. Only these two solanaceous species at Cuesta Angel provide oviposition sites and larval food for *P. notilla*.

Life cycle and developmental time. The oblong-shaped egg is 1.2 mm high by 1.0 mm wide at the middle. It is marked by several vertical grooves, and the top is rounded (Fig. 2,B); the egg is uniformly white until the hatching of the first instar larva.

The first instar larva is generally dark green in color, once it begins to feed on plant tissue. By the time of the first molt, it is about 3.5 mm long. The first, second, and third instars are virtually identical in appearance (Fig. 2C,D,E). Each larva is dark green dorsally. On each side dorsolaterally, a thick light green line runs from the first thoracic segment to the anal plate (Fig. 2,E). Beneath this pair of lines the body continues to be dark green for an additional fraction of a mm; then this color gives away to light translucent green. The head in

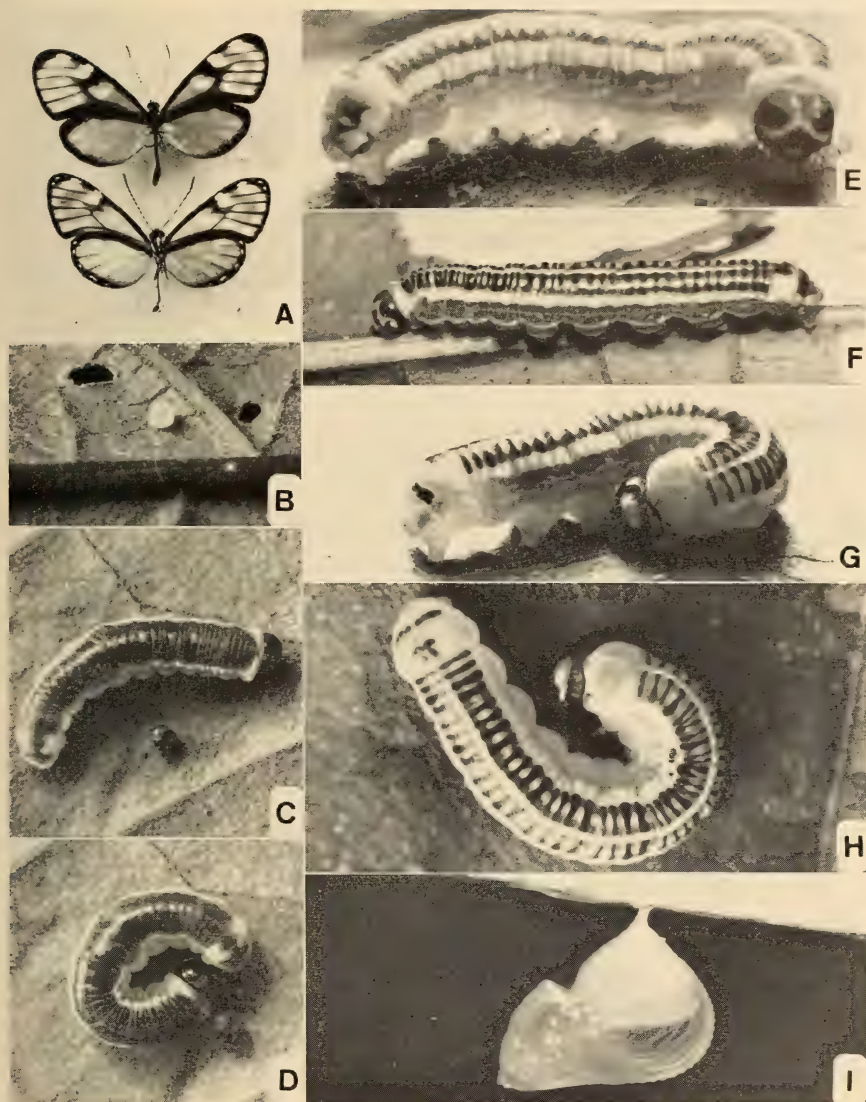


Fig. 2. Life stages of *Pteronymia notilla*: (A) adult (dorsal and ventral aspects); (B) egg; (C) second instar, dorsal aspect; (D) second instar in curled-up position (presumably defensive); (E) third instar, lateral aspect; (F) fourth instar, lateral aspect; (G) fifth instar in curled-up position (presumably defensive); (H) fifth instar, dorsal aspect; and (I) pupa, lateral aspect. Dimensions of life stages are given in the text.

all three of these instars is shiny black, but has a mask-like appearance, resulting from a three-pronged, forked light green line, that superficially divides the head into three regions (Fig. 2,E). The anterior edge of the first thoracic segment behind the head is enlarged and orange-yellow. The anal plate is dark green and bordered with thick patches of yellow. The true legs are dark green and the false feet are light green. The second instar attains a length of 6.5 mm by the second molt, and the third instar is about 12.0 mm long by the third molt.

The fourth and fifth instars are identical to one another in coloration, but very different from the previous three instars (Fig. 2F,G,H). The dorsal color pattern consists of a thin medial light blue line running from the first thoracic segment to the anal plate, and bordered to either side by an alternating series of short light blue and dark green bands, running perpendicular to the central blue line (Fig. 2,H). These series of bands do not extend to the head and anal plate: anteriorly, there is a swollen region just behind the head, and posteriorly, there is another one just before the anal plate. The anterior swollen region forms a light green collar ringed with orange; the posterior swollen region is uniformly bright orange, but does not cover the entire dorsal region (Fig. 2,H). The light green thick dorso-lateral line of the previous instars is now yellow, and the body beneath it is light green. The thin, central blue line continues through both swollen areas. Just behind the swollen anal region, there is one segment bearing the typical body color pattern.

The head of the fourth and fifth instars now appears to be much smaller due to the swollen aspect of the anterior trunk segments. It is shiny black with the inverted "Y" portion of the light green line pattern being thicker than in the previous instars (Fig. 2,G). Finally, there is a thin yellow lateral line running the length of the body, located just where the ventrum joins the lateral aspects of the body. The fourth and fifth instars are much more brightly colored than the previous instars. The larva is about 16 mm long by the end of the fourth instar, and about 22 mm long by the end of the fifth instar.

Immediately prior to pupation, the fifth instar larva contracts in length and becomes a uniform green color. This prepupa produces a pupa (Fig. 2,I) which is uniformly light green and slightly reflective. The pupa is remarkably translucent with only abdominal regions being clouded over with a yellowish coloration just beneath the cuticle. The cremaster is light red. The pupa is about 17 mm long by 7 mm wide (dorsoventrally) through the thoracic region. The coloration of the pupa does not change appreciably prior to the eclosion of the adult.

There is very little sexual dimorphism in coloration of the wings in

TABLE 1. The developmental time (days) of *Pteronymia notilla* on *Cestrum megalophyllum* (Solanaceae) in the laboratory.*

	EGG	INSTARS					PUPA	TOTAL EGG- ADULT
		1	2	3	4	5		
MEAN	5	2	2	3	5	6	7	30
± S.E.	± 0.3	± 0.2	± 0.1	± 0.1	± 0.6	± 0.7	± 1.1	
No. Individuals Measured (N)	24	24	21	21	21	21	20	

* All measurements were made in one laboratory in San Jose, Costa Rica. During this time, laboratory conditions were 21–23° C and 40–60% relative humidity. See text for further details.

the adult (Fig. 2,A); good descriptions are given by R. Haensch in Seitz (1924) and by Fox (1968). For a total of 20 individuals reared in the laboratory, the mean length of the forewing is 25 ± 0.7 mm, which is very similar to forewing length of wild caught individuals.

The egg through adult developmental time in the laboratory required 30 days (Table 1). Developmental time is undoubtedly quite variable in the field.

Larval behavior. The larvae of *P. notilla* generally occur singly on leaves of the foodplant; there is no evidence of gregarious behavior when more than one larva is present on an individual plant. Both resting and feeding are confined to the undersurfaces of leaves, and the larvae of all instars are most frequently found in the field on older leaves. Pupa- tion often occurs on the foodplant and both living pupae and hatched pupal cases have been found on the undersurfaces of leaves attached along a major rib. The earlier instars (1–3) are very cryptic in appearance, and are very difficult to find on foodplants in the wild. Despite the increased conspicuousness of the later instars (4–5), there are no noticeable changes in larval habits and behavior. Individuals of all instars exhibit a pronounced curling up behavior upon tactile contact with forceps (Fig. 2D,H); this behavior may be defensive.

Individual larvae build silken trails over leaves and stems, but there is no nest construction as seen in the solitary larvae of *Hymenitis nero* (Young, 1972a). Furthermore, there is no “dropping off” behavior, where individual larvae suspend themselves from long silken threads as a means of escaping predatory attack. Such behavior has been noted for various ithomiine larvae, and it has recently been seen in *Dircenna relata* where the larvae are semi-gregarious (Young, 1972b).

Adult behavior. Adults are often seen flying about 1–2 m from the ground in forest understory. Presumably adults spend a substantial

amount of time cruising for courtship encounters and searching for oviposition sites. Courtship has not been observed in *P. notilla*. The reproductive strategy of *P. notilla* involves carefully laying each egg singly on the ventral surface of older leaves of *Cestrum megalophyllum* and *Capsicum* sp. Eggs are also laid on the large leaves coming from suckers of cut-down trees.

In a total of 13 oviposition sequences observed on five different dates, there were six in which the female laid more than one egg on a single leaf. In these instances, there were no more than three eggs laid on the leaf. Furthermore, the eggs were never close to one another, but were widely scattered on the under surface of the leaf. On a visit to a single foodplant tree, an ovipositing female would lay anywhere from one to seven eggs in the tree; there were never more than three eggs on a leaf when multiple ovipositions were seen.

Egg laying involved the female landing on the ventral surface. The female walked toward the interior of the leaf and laid the egg. If more than one egg was to be laid, there were brief periods of walking before laying the next egg. Eggs were never laid near the edges of the leaves. Oviposition has been observed at various times throughout the morning, but seldom during the afternoon hours. There appears to be no correlation between time of oviposition and the amount of sunshine filtering down through the forest canopy. Females often rest for several minutes between oviposition sequences.

DISCUSSION

P. notilla differs from other ithomiids in a number of ways: first, egg color and external morphology when compared with that of two other recently studied species in Costa Rica, namely, *Hymenitis nero* and *Dircenna relata* (Young, 1972a,b). The egg of *H. nero* is white and less oblong than the egg of *P. notilla*, but it has the same distribution of vertical grooves as in the latter. The egg of *D. relata* is deep yellow and has the general shape of the egg of *H. nero*; but unlike both this species and *P. notilla*, there is a complex series of short horizontal grooves evenly-spaced between adjacent vertical grooves on the external surface.

The larval stages of these three species are very different in appearance and of these three, only the fourth and fifth instars of *P. notilla* show a dramatic change in coloration from the previous instars (Fig. 2); similar changes in color are not seen in the other two species. The larvae of both *H. nero* and *D. relata* retain a generally mottled green cryptic appearance throughout all instars (Young, 1972a,b). Furthermore, the

pupa of *D. relata* is extensively covered with gold coloration, especially on wing pads and dorsal aspects of the thoracic and abdominal regions.

The pupa of *H. nero* is heavily adorned with a bright silver coloration on the wing pads and thorax. Such highly reflective silver or gold pigmentation is entirely absent from the pupa of *P. notilla*, in which protective coloration is limited to light green translucence with relatively minor reflectance properties. Finally, the developmental time for these three ithomiid butterflies is between 25 and 30 days in the laboratory.

These three species also illustrate ecological divergence in the Ithomiidae with respect to larval foodplants. While it is known that most Ithomiidae feed on various Solanaceae (e.g. Brower & Brower, 1964; Ehrlich & Raven, 1965), little is known about patterns of divergence in foodplant exploitation at the generic and species levels among these butterflies. Such information is clearly of great importance in studying the community structure of the butterflies.

In the present situation, at least two sympatric ithomiids, *P. notilla* and *H. nero*, exploit different species of *Cestrum* in the forest understory of Cuesta Angel. *D. relata* is found in *S. hispidum* at one locality (Bajo la Hondura) on the Pacific slopes of the Central Cordillera (Young, 1972b); the butterfly also occurs at Cuesta Angel, but the larval foodplant has not yet been determined. However it is likely that this species feeds on different foodplants than both *P. notilla* and *H. nero* at Cuesta Angel. While *H. nero* is a blue clear-winged species of ithomiid, *P. notilla* is one of the more conspicuous orange-winged species. The showy coloration of the late instars of the latter species may be indicative of noxious or unpalatable properties of older larvae, pupae, and adults. Clear-winged species such as *H. nero* are presumably more palatable, since their immature stages employ a more pronounced strategy of crypsis than is seen in *P. notilla*: the larvae are cryptically-colored throughout all instars; the pupae are more effective in resembling large drops of rain water hanging from leaves (e.g., Brower, 1971); and the larvae construct nests of partially closed leaves where they rest when not feeding (Young, 1972a).

Furthermore, the transparent qualities of the wings make the adults rather inconspicuous in shaded forest understory. This apparent divergence in adaptive strategy is interesting since both species feed on related species of *Cestrum*. Such a divergence in larval feeding habits is illustrative of very subtle environmental factors (i.e., species differences in secondary compounds among congeneric sympatric plants), which influence the evolution of morphological and behavioral traits among

herbivorous larvae toward either crypsis or warning coloration, two very different adaptive strategies.

But orange-winged species of ithomiids, like *P. notilla*, may not be as unpalatable as other orange-winged genera such as *Dircenna* and *Mechanitis*. This is suggested by several factors: (1) oviposition in *D. relata* is semi-clustered, while it is single in *P. notilla* (Young, 1972b); (2) oviposition is clustered in *M. isthmia*; (3) larvae are semi-gregarious in *D. relata* (Young, 1972b) and gregarious in *M. isthmia*, but solitary in *P. notilla*; (4) the dorsal wing surfaces of *D. relata* are brighter than those of *P. notilla*, whereas those of *M. isthmia* are strongly mimetic, since they have familiar tiger-striped pattern of various heliconiids and the danaid *Lycorea*.

The observed differences in life cycles, larval foodplant utilization, and dorsal wing surface coloration among different genera of the Ithomiidae suggest that differences in adaptive strategy with respect to escape from predators have evolved. One lesson to be learned from such preliminary assays of ithomiine natural history is that experimental feeding studies utilizing a wide range of vertebrate and invertebrate predators must be performed to demonstrate differences in the relative palability of adults and larvae among different genera. Such studies must be accompanied by field studies elucidating various behavioral patterns (e.g., communal roosting, alarm positions, etc.) which may be correlated with increasing unpalatability in heliconiid butterflies (Benson, 1971).

SUMMARY

(1) The life cycle and developmental time of the ithomiid *Pteronymia notilla* Butler & Druce are given for individuals reared from eggs collected at one montane tropical forest locality in central Costa Rica. The developmental time in the laboratory is about 30 days and fourth and fifth instar are brightly colored relative to earlier instars.

(2) The major larval foodplant at the bottom of the ravine where the species was studied is *Cestrum megalophyllum* (Solanaceae). Further up the side of the ravine, another foodplant is *Capsicum* sp. (Solanaceae). Both species occur as small woody understory trees.

(3) Both eggs and larvae generally occur singly on the foodplants, and there is no evidence of cluster oviposition and larval gregariousness, as noted in other ithomiids.

(4) Oviposition is precise in this species and involves the female walking to a suitable spot on the ventral leaf surface before an egg is

laid. Females seem to show some selectivity, preferring to oviposit on older leaves.

(5) The noticeable change in larval appearance at the third molt is suggestive of increased unpalatability, which may be carried over to the adult stage. Orange-winged ithomiids such as *P. notilla* appear to the human observer more conspicuous than clear-winged species of comparable wingspan. The unpalatability of dull orange species like *P. notilla*, however, may be weak, since some of the more bright-orange genera (*Dircenna* and *Mechanitis*) have life cycles in which oviposition is clustered and larvae are gregarious. These forms are presumably more unpalatable than similar appearing ithomiids with solitary oviposition habits and non-gregarious larvae. Such correlations, however, are very tentative, in the absence of experimental data on the relative palatability of adults and immatures for representatives of different genera.

ACKNOWLEDGMENTS

I am very grateful to Lawrence University for supporting this research through a College Science Improvement Grant (COSIP-GY-4711) during the summer of 1971. Laboratory facilities and logistic support was provided by the Costa Rican Field Studies Program of the Associated Colleges of the Midwest. Patrick Eagan assisted in all aspects of the field and laboratory work. Drs. Lee D. Miller and Keith S. Brown, Jr. identified the species studied. Dr. Dieter C. Wasshausen of the Smithsonian Institution identified the larval foodplants.

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CELASTRINA EBENINA (LYCAENIDAE) IN NORTH CAROLINA

Recently Clench (1972, *Ann. Carnegie Mus.* 44: 33–44) described a new species of Lycaenidae, *Celastrina ebenina*. This butterfly was formerly known as a "black form" of the common *C. argiolus pseudargiolus*: form ♂ *nig* and form ♀ *intermedia* as listed by dos Passos (1964, *Lepid. Soc., Mem.* 1: 69, 481). Clench asked me to be on the lookout for this species and on 29 April 1972, I took two males in Buncombe County, North Carolina, and sent them to him. My find extended the confirmed range into North Carolina.

On 21 April 1973 I took another male and on 4 May 1973 I found a single female. All of the *ebenina* I have taken were found in Buncombe County, North Carolina, along the dirt road which is an extension of Buncombe County road number 2178 south of its junction with county road 2173 at Dillingham, a small community near Barnardsville. The two taken in 1973 were found about 2.1 miles south of the junction near the parking place on the left side of the road (elevation about 2880'). A mountain stream parallels the road on the right at this point. The two taken in 1972 were found about 3 miles south of the junction (elevation about 3260'). This road runs from Dillingham to the Blue Ridge Parkway, and the locations described can therefore be reached by driving north (down the mountain) from the Parkway.

I am publishing this note to encourage other collectors to look for this butterfly in the southeastern mountains of the United States. According to Clench it should be sought in cool, moist, forested ravines and is almost always found near areas where *Trillium grandiflorum* is in bloom. The habitat in which I took *ebenina* matches perfectly with this description which Clench gave of the other areas in which it has been taken. I would be pleased to hear from others who find it.

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PIERIS BRASSICAE L. ESTABLISHED IN CHILE;
ANOTHER PALEARCTIC PEST CROSSES THE ATLANTIC
(PIERIDAE)

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In about 1860 *Pieris rapae* L. (the imported cabbage worm) was recorded from Canada (Seitz, 1924). It spread rapidly and already by 1870 was causing great damage to cruciferous truck crops from Montreal to New York and within a surprisingly short time had spread throughout the Union (Chittenden, 1905).

In 1972 I received for identification some white butterflies from the region of Santiago, Chile. They are undoubtedly *Pieris brassicae* L., the large cabbage white butterfly, to give it its English vernacular name. The specimens were forwarded to me by fellow member J. H. Robert who had received them from Sr. Luis E. Peña who reports that they are now (1972) "flying around gardens in the vicinity of Santiago" which means the species is clearly established and was doubtless introduced some years ago. In view of the enormously rapid rate of spread of which *Pieris* species are so clearly capable it would seem desirable to give some details of it so that it can be immediately recognised and dealt with, if that be possible. Already grave concern is being expressed about an African honeybee, *Apis mellifera adansonii*, which is sixteen years has spread virtually throughout the whole of South America and is heading fast toward the U.S. (Orsak, 1973). It would seem quite possible for *P. brassicae* to follow the same course, it is a noted migrant and just as fond of Cruciferae as is *P. rapae*; indeed its larvae will feed on plants of any family containing mustard oil glucosides. However, in the Canary Islands it is not a pest, the larvae feeding only on *Tropaeolum* (Fernandez, 1955).

The probability that it will now spread through South America appears to be a very real one, as Sr. Peña informed me in June 1973 that it is already widespread in all the Province of Valparaiso and adults are already flying in other provinces and the Cruciferae are being destroyed. It would seem desirable therefore to take the opportunity to give some account of the species, so that it can be looked out for; and at the same time to correct certain errors concerning it in the literature and put on record some new observations. *P. brassicae* differs

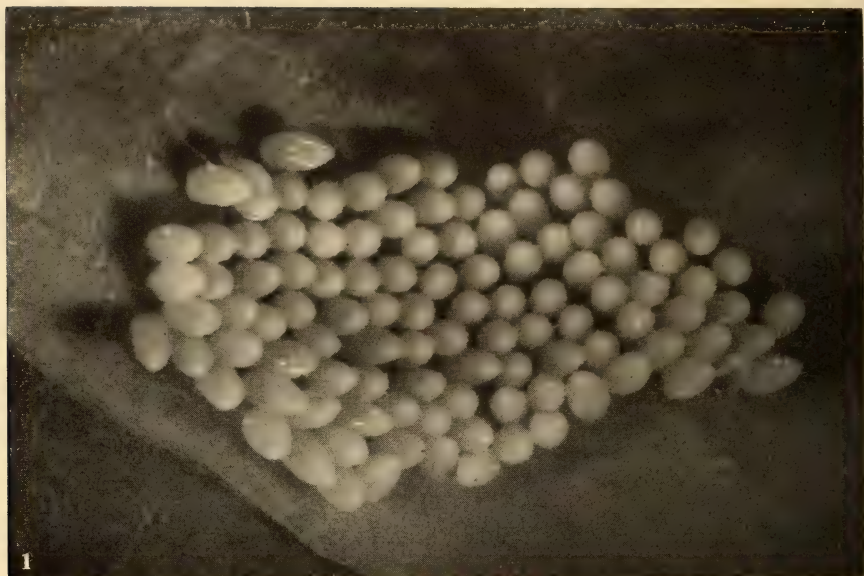


Fig. 1. Typical eggbatch of *P. brassicae*.

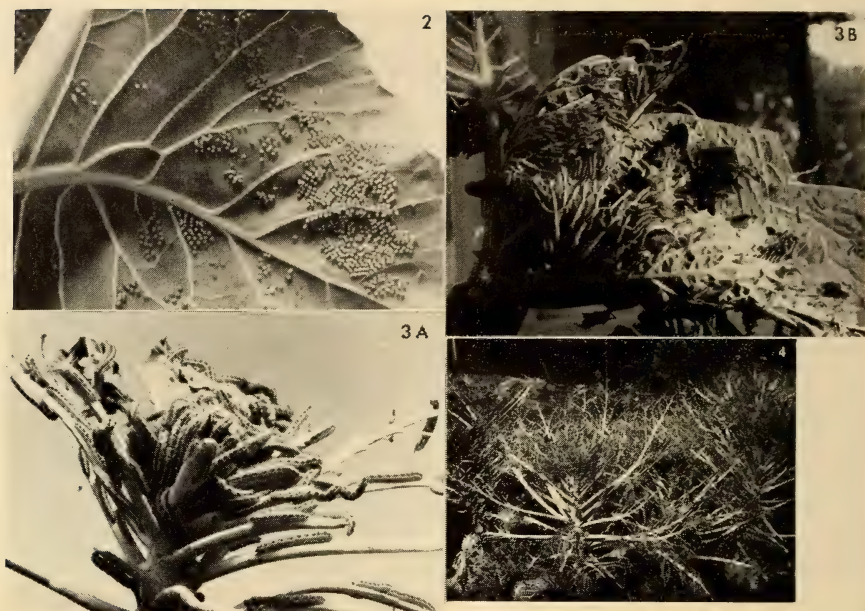
quite markedly from other European members of the genus. There are some quite good reasons for considering that it should be separated off into another genus, and it is only the great confusion that this would cause that seems to have prevented this step from being irrevocably taken.

Egg. Fig. 1 shows a batch of eggs and Fig. 2 eggs *in situ* on cabbage. They are laid in more or less regularly arranged batches which vary in size from a few eggs to a hundred or more, the number varying according to the age of the butterfly, with an average around 40–50. When first laid the eggs are a very pale straw color; within twenty four hours this has darkened to yellow and in at least one subspecies (*P. b. cheiranthi* Hueb) they are bright orange. Eggs from butterflies whose larvae have been reared on semi-synthetic diets not containing cabbage leaf powder, remain a very pale straw color, indeed may be almost white. A female is capable of producing 750 eggs during a full lifespan (David & Gardiner, 1962) but it is doubtful if the full number is ever produced under feral conditions. In very warm weather the eggs will hatch in 4–6 days but may well take 2–3 weeks in cold weather. A few hours before hatching the eggs turn black and the form of the larva can be seen through the shell. The first larvae to hatch turn round and often commence to eat the tops of the shells of the other

larvae. In this fashion the hatch of a batch of eggs will take place over about 30 minutes. The young larvae consume the eggshells and then, en mass, spin a silken pad on which they rest when not feeding.

Larva. Fullgrown larvae are shown in Fig. 3A. The larvae are gregarious throughout their life, unlike *P. rapae* and other "small white species" which are not only solitary, but cannibalistic, both to smaller brethren and, in particular, to their own eggs, which they eat and kill (unlike *brassicae* which merely eat the top of the shell and release the contained larva). They invariably have five instars and, depending on the temperature, the larval stage lasts from two to eight weeks. It has been erroneously stated by both Klots (1958) and more recently again by Wigglesworth (1972) that five instars only occur under cold conditions and that the number of instars falls to four and finally only three as the temperature of rearing increases. These statements are based on an observation of Klein (1932). Frohawk (1934), a careful recorder, who had the experience of rearing every species of British butterfly, considered only five instars, and David & Gardiner (1962a) proved conclusively that the number of instars is constant at five over the very wide range of environmental conditions at which rearing is possible, and further extensive rearing by the present author with various stocks and races of *brassicae* has subsequently confirmed this. The color of the larvae is virtually the same in all instars; blue-grey or yellowish ground color, a yellow dorsal stripe and irregular and intricate black markings which are more intense the lower the temperature of development. The yellowish ground color is recessive to the blue-grey (David & Gardiner, 1962a) but appears to be so common in the wild that there must be some advantage in it. The larvae prefer to feed openly on the outside of the leaves. Fig. 3B shows an aggregate of mainly fourth instar larvae and Fig. 4 the remains of a garden cabbage plot.

Chrysalis. These are formed in a similar fashion to those of *P. rapae*, that is to say suspended by a cremaster and a silken girdle. Also as in *P. rapae* similar situations are sought by the larvae in which to pupate. The color of the chrysalis is either a pale straw or a shade of green, with variable black markings, and in general the color is lighter or darker according to the background. It has been stated (Babers & Pratt, 1952) that the color is influenced by the illumination of the larva before pupation. As a result of numerous experiments and the rearing of more than one million larvae I have never found any evidence of this. I have, however, found conclusive evidence that diapausing chrysalids are much more inclined to be green in color than summer



Figs. 2-4. *P. brassicae*: 2, eggs *in situ* on cabbage leaf; 3A, fullgrown larvae on same plant; 3B, gregarious cluster of mainly fourth instar larvae; 4, devastated crop of cabbages in a garden plot.

brood ones (Gardiner, in prep.). This was strikingly born out by the chrysalids I received from Chile, the straw-colored ones eclosed a few days after receipt; the green-colored ones are still unchanged after several weeks and therefore clearly in diapause.

The pupal stage of summer brood specimens lasts 10 days in warm weather, but may be as long as 60 days if the weather is cold. If the pupa has entered diapause then this stage will last for 6-8 months.

Adult. In general appearance the adults of *P. brassicae* are similar to those of the imported cabbage worm *P. rapae*, but are quite distinctive and sexually dimorphic. In particular the black markings have a sharp cut-off from the white instead of the gradual fade-out from one to the other as in *P. rapae* and *P. napi*. Both sexes are white with a black apical spot. The female only, has two black distal spots and a black discal streak along the inner margin. Both sexes have two black discal spots on the underside.

The underside of the hindwing tends to be very variable and may be yellow to orange (race *cheiranthi*); or pale straw, greenish, and at times almost black. Greenish and blackish forms are an over-all effect

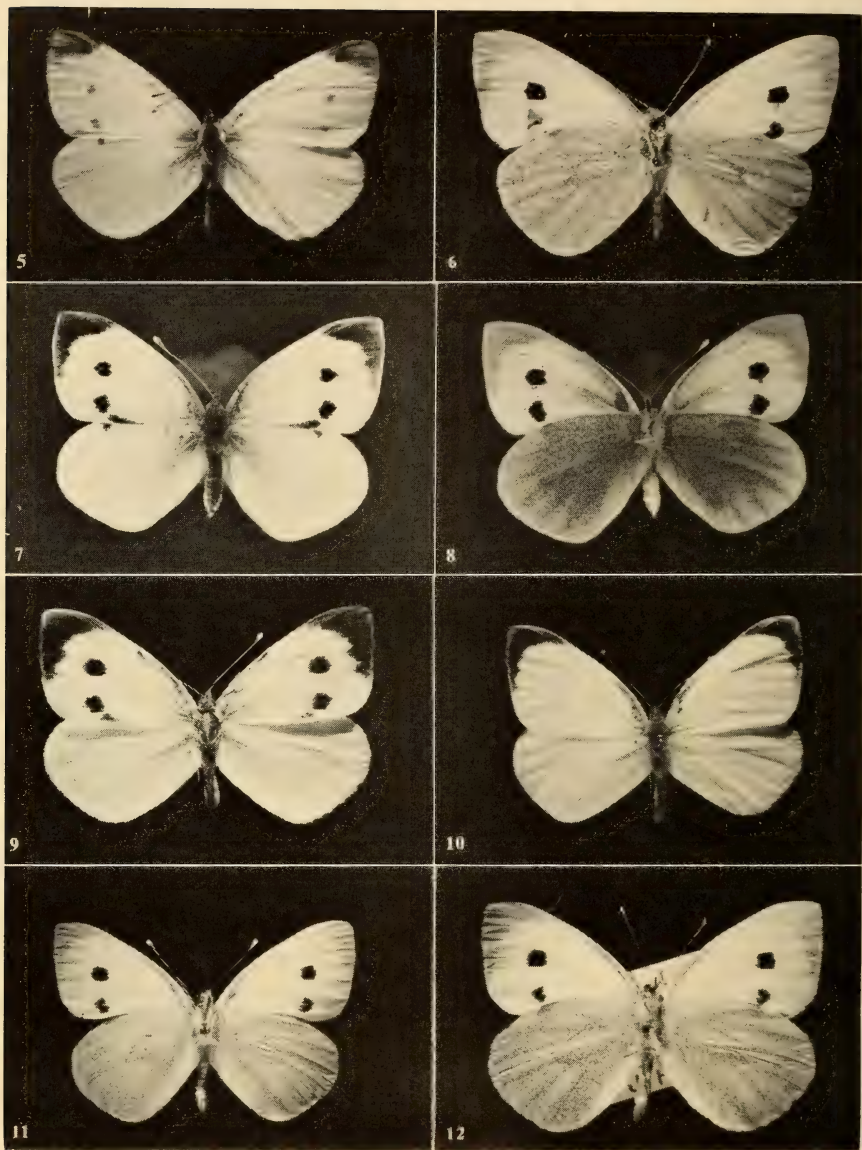
produced by a light to heavy sprinkling of black scales. Unlike other *Pieris* species the veins of the wings in *brassicae* are never heavily marked to give a rayed or chequered effect. In size *brassicae* is larger than all other United States *Pieris* with a wingspan of from 55–65 mm in certain bred examples (David & Gardiner, 1961), up to 63–76 mm in wild caught specimens (Frohawke, 1934). All other United States *Pieris* have a wingspan of under 50 mm (Chang, 1963).

P. rapae crucivora from Japan are exceptionally large. Esaki & Yokoyama (1955) give the wingspan as 55 mm and I have bred specimens up to 60 mm. Fig. 5 shows one such bred specimen for comparison with *brassicae*. Since Esaki & Yokoyama use a different basis for their wingspan measurement than Chang (which gives a lesser figure), the actual size of *P. r. crucivora* comes out as the mean of the *P. brassicae* bred by David & Gardiner (1961). As in other *Pieris* the black coloring of the spring brood is much paler than in the summer broods.

The Chilean examples have the typical upperside facies, but the hindwing underside is of the dark green form. This form certainly occurs in British, Spanish, German, and Maltese race *wollastoni*, and in East European *brassicae*, but an examination of my collection and of the extensive series in the insect room of the Cambridge University Museum of Zoology reveal that it is uncommon, the lighter forms being by far the more numerous. It does not therefore seem possible to pin down the exact origin of the Chilean *P. brassicae*. It has been suggested by Sr. Peña that they may have come from Eastern Europe, there now being considerable trade between there and Chile. What is more certain is that the specimens are not of one of the numerous races of *P. brassicae*, which has distinct forms in certain parts of its range where it also appears to be non-migratory. Details of the distribution are given in Fig. 13.

Three of the Chilean specimens are shown in Figs. 6,7,8. For comparison, a typical English pair (Figs. 9,10), the male English underside (Fig. 11), and the dark green form of a Spanish example (Fig. 12) are shown.

The dark green color on the hindwing underside of the Chilean examples is interesting. This may well be due to adaptation to certain environmental factors which confers some advantage in a particular area. It has already been shown by Gardiner (1973) that the facies of *brassicae* can be changed by careful selective breeding, and the dark green and the yellow form of the hindwing underside are amongst the characters which can be so selected. The Cambridge stock of *brassicae*, as was maintained for so many years by David & Gardiner,



Figs. 5-12. Various imagoes for comparison: 5, *P. rapae crucivora* ♀ ex Japan; 6-12 *P. brassicae*: 6, ♂ underside ex Chili; 7, ♀ upperside ex Chile; 8, ♂ underside ex Chili; 9, ♀ upperside ex David & Gardiner's "Cambridge" stock; 10, ♂ upperside ex "Cambridge" stock; 11, ♂ underside ex "Cambridge" stock; 12, ♂ underside ex Spain.



Fig. 13. Palearctic distribution of *P. brassicae* (within heavy line), and area in South America from which now recorded.

has rather a light straw-colored underside and I have similar specimens in my collection from most areas of Europe and also from the North African littoral and near East. It will be interesting to hear in due course if all Chilean examples are of this dark green form or if the lighter colored ones are also to be found. The question of this underside coloration presents a good opportunity for some field research. Eastern European and Asiatic material is not so readily available but I have seen all types of underside from those areas.

P. brassicae is a well known migrant. Although, due to destruction of former breeding areas, very vast swarms no longer occur, regular migration usually in a southerly and westerly direction still takes place. Return flight does not occur. The insects migrate within a day or two of emergence, the females often mated, but not yet with mature eggs, and are capable of traversing up to 250 miles, without food, in a few days. (For further details, see Johnson, 1969.) It can therefore readily be appreciated that, once a nucleus colony is established, a very rapid spread of the butterfly can take place.

Diapause. *P. brassicae* has a facultative diapause controlled by the daylength on the larva (Way, Smith & Hopkins, 1949; David & Gardiner, 1962a). Consequently as long as the daylength is sixteen hours or longer, dawn to dusk, and the temperature averages above 10° C, there will be a continuous succession of broods, at least one every six weeks in very warm tropical weather. As soon as the daylength falls the pupae will enter diapause. All summer brood stages can withstand frost for

short periods and diapausing pupae can withstand severe and prolonged winter conditions. There is no doubt that the species must be considered very hardy.

Parasites, predators and diseases. *P. brassicae* larvae are parasitized by a number of *Apanteles* species, in particular *A. glomeratus* L., which is known to attack *P. rapae* in the United States (Blunck, 1957). The pupa is also parasitised by *Pteromalus puparum* L., which is believed to have been imported into the States at the same time as *P. rapae* which it also attacks (Chittenden, 1905). Both larvae and adults are also predated by social Hymenoptera. The only avian predator which has been observed eating the very distasteful larvae is the European thrush, *Turdus musicus* L. Flying adults are sometimes attacked but appear to be rarely eaten by birds, although mice (*Mus musculus* L.) will eat the bodies. The pupae, however, are eaten in considerable numbers (Moss, 1933). Eggs do not seem to be attacked by any parasite or predator and even larvae of its own kind have been observed by me to eat carefully round egg batches without doing them any damage. Various potential parasites already present in the Nearctic region, notably *A. rubecula*, which helps to control *P. rapae* and could also attack *P. brassicae*, have recently been surveyed by Blunck (1957) and Wilkinson (1966). Various species of ant have been observed in England to carry off and consume the young larvae. Microsporidian parasites are recorded from Europe (but not England), but Blunck (1957) could not find these in the United States.

P. brassicae is certainly susceptible to many of the usual commercial insecticides and also to *Bacillus thuringiensis*. From time to time the larvae and pupae succumb to an undescribed bacteria, but it is my experience that they are far less susceptible in this respect than many other species of Lepidoptera. However, they are very susceptible indeed to a granulosis virus disease. Although the virus might be the better method of control, it is not yet commercially available, although *B. thuringiensis* is. (For data on these two possible control agents, see Burges & Hussey, 1971.) Although certainly susceptible to many insecticides, *brassicae* is difficult to eradicate and its present-day cessation as a major pest in large parts of the palearctic region is due in my view not so much to control measures as such, but to changed agricultural practices and, above all, to the bringing into other uses of enormous areas of its former wild breeding areas with consequent wholesale destruction of its foodplants in these areas. The enormous migrations recorded fifty and more years ago no longer occur.

ACKNOWLEDGMENTS

I am indebted to Sr. J. H. Robert of Alicante, Spain for forwarding to me the original Chilean specimens and for Spanish examples of *P. brassicae*; to Sr. Luis E. Peña of Santiago, Chili for subsequent live material and information from Chili; to Hr. Hermann Wilde of Darmstadt, Germany for Fig. 4 and to Mr. G. H. Runnalls and Miss Yvonne R. Carter of this Department for photographic help.

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COMPARATIVE NOTES ON CERTAIN WEST-PALEARCTIC
SPECIES OF *AGRIADES*, WITH DESCRIPTION OF A
NEW SUBSPECIES OF *A. PYRENAICUS* FROM TURKEY
(LYCAENIDAE)

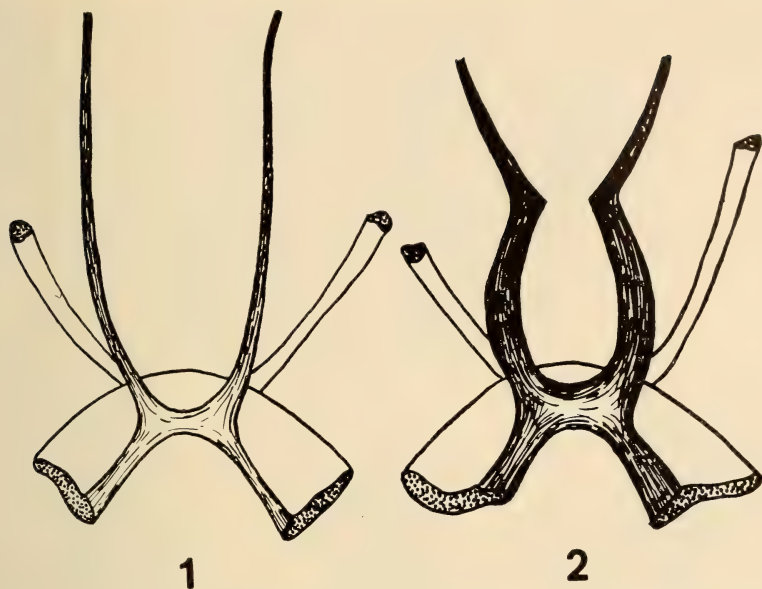
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A study of the composition, spatial differentiation and zoogeographic connections of the Caucasus butterfly fauna requires verification of the species determinations given by former authors. Direct comparison of material collected in the Caucasus area with published data often shows disagreement between the species and the names attributed to them by different authors. Such a case has been exemplified recently with *Eumedonia eumedon* Esper (Nekrutenko, 1972). One of the most important points in taxonomically-based faunistic speculations is good knowledge of the fauna in adjoining areas. It would be no exaggeration to say that a reliable, 'three dimensional' picture of the Caucasus butterfly fauna requires two essential conditions: familiarity with the European fauna in order to compare the local forms with their nomenotypic subspecies and, on the other hand, knowledge of the fauna of Turkey and Iran in order to detect clinal intergradations where they exist.

In this paper I consider another case of taxonomic uncertainty regarding the position of the Caucasian representative of the [sub] genus *Agriades* Hübner (*Polyommatus* Latreille, pars), and I describe a new subspecies of *A. pyrenaicus* from Ulu-Dağ, Turkey, as a link in the intergrading chain of its geographic subspecies.

As is fairly obvious from synonymic lists, under the description of *A. pyrenaicus latedisjunctus* Alberti, authors almost unanimously have attributed Caucasian *Agriades* to *dardanus* Freyer, which is considered by them to belong, as a subspecies, to *glandon* Prunner (= *orbitulus* auct., for history see Hemming, 1967), or to *pyrenaicus* Boisduval. Such a situation necessitates answers to two essential questions: (1) to what species does *dardanus* really belong, and (2) do Caucasian *Agriades* belong to *dardanus*. As part of the alternative (*glandon* versus *pyrenaicus*), there are two other possible taxonomic interpretations of these forms: (3) to synonymize *dardanus* with *pyrenaicus* (Forster, 1938) and/or (4) to consider *dardanus* as a distinct species, according to Freyer's (1845) original combination (Sauter, 1968).

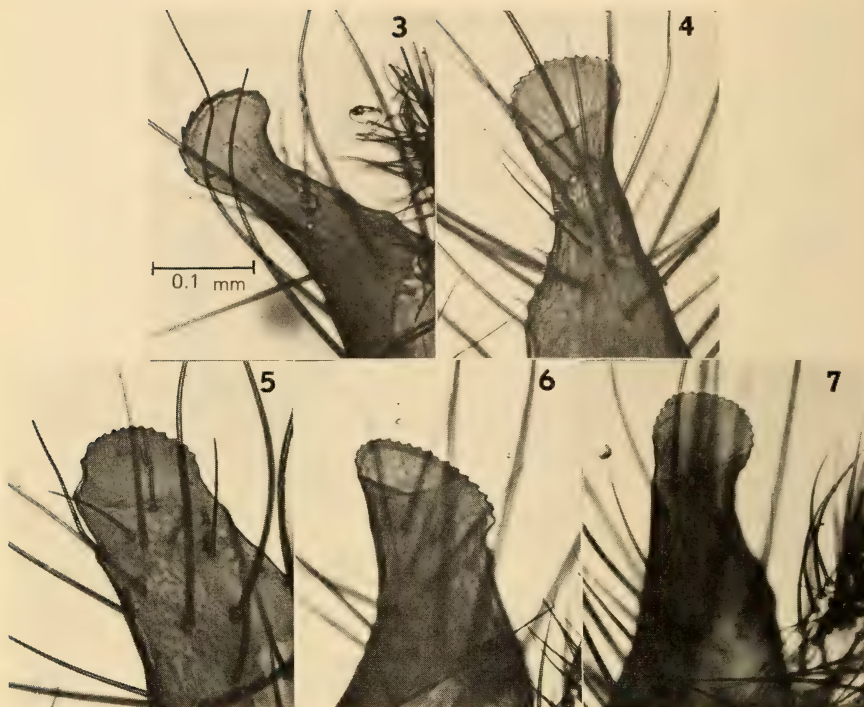


Figs. 1, 2. Two types of juxta structure in *Agriades*: 1, *glandon* and *aquilo*; 2, *pyrenaicus* and its subspecies.

As has been shown by Chapman (1908) and Bethune-Baker (1913) the peculiarities of the "ancillary appendages," especially differences in the structure of the tip of the upper valval lobe, are of high value for recognition, so that there are no problems with exact determination of *glandon* and *pyrenaicus* on the basis of the male genitalia (see also Oberthür, 1910); however, they are practically unrecognizable on female genitalic characters. When dissecting a large sample of both *glandon* and *pyrenaicus*, collected over an extended area, I found an additional, highly exact character permitting the determination of these species at a glance with 100% confidence. This diagnostic character consists of a pronounced structural difference in the juxta between *pyrenaicus* and other *Agriades* species, as depicted in Figs. 1 & 2. It is curious that this character, so clearly visible on the excellent microphotographs of Chapman (1908), and in illustrations in the recent paper of Fernández-Rubio (1970), was not pointed out in the text of either author and thus seems to have been overlooked.

The type locality of "*Lycaena dardanus*" was designated by Freyer (1845) as "europäische Türkei."¹ The illustrated text of its original

¹ Not "Freyer 1844 (Typenfundgebiet "Türkei")" as stated by Alberti (1973).



Figs. 3-7. The tip of the upper valval lobe (right): 3, *glandon*, Col d'Allos, Basses Alpes, 2500 m, Gallia mer., 11 August 1968, G. Hesselbarth leg.; 4, *pyrenaicus*, Cèdre, Htes Pyrénées, Rondou (Zool. Mus. Kiev Univ.); 5, *dardanus*, Cvrstnica Planina, Hercegovina, O. Leonhard leg. (Zool. Mus. Kiev Univ.); 6, *latedisjunctus*, Kazbek Mt., C. Caucasus (Y. Nekrutenko); 7, *hesselbarthi*, Ulu-Dağ, Prov. Bursa, Anatolia sept. 17 July 1973, G. Hesselbarth leg.

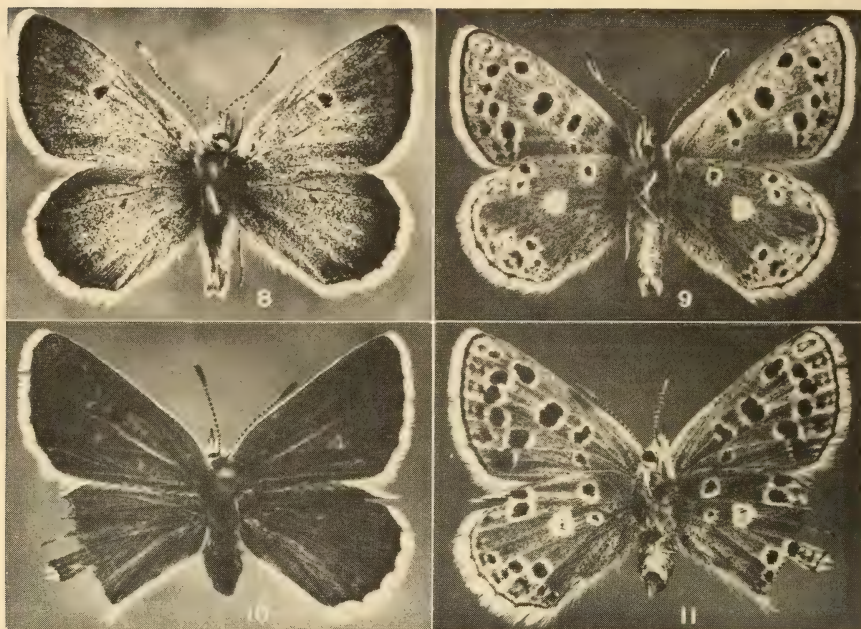
description agrees fully with characteristics given by Higgins & Riley (1970) of specimens from Cvrstnica Planina in Hercegovina (Yugoslavia), so that specimens from this locality may be considered as "true" *dardanus*. In addition to specimens from Cvrstnica Planina, in the collection of the Kiev State University Zoological Museum, there is also a short series of similar specimens labelled "Alibotusch Gebirge, 1900 m, Al.K.Drenowski leg.," determined by L. Sheljuzhko (in litt., labels) and by Buresh & Tuleshkov (1930) as *dardanus*. Dissection of the male genitalia showed the complete identity in juxta shape in these two samples with *pyrenaicus* from Pyrenees and *latedisjunctus* from Caucasus, respectively. At the same time, the shape of the upper valval lobe tip decidedly differs in *glandon*, *pyrenaicus*, "true" *dardanus*, *latedisjunctus* and *hesselbarthi* n. subsp. (Figs. 3-7).

The aforementioned may lead only to the conclusion that, contrary to Higgins & Riley (1970), and in agreement with Bramson (1890), Egorov (1903) and Alberti (1970, 1973), *dardanus* should be considered as a subspecies of *pyrenaicus*, not of *glandon*. This way, the range of *pyrenaicus* becomes far more extended than is seen from the literature, and the occurrence of *glandon* should be restricted, according to available data, to the Alps. However, there are no genitalic characteristics to recognize *glandon* from *aquilo* Boisduval, a circumpolar holarctic species with a significant number of subspecies over its wide range. The question of interrelations between these taxa remains open. Also remaining open is the question of the possible occurrence of *glandon* (a geographic isolate?) in the Caucasus region. As has been observed by Fernández-Rubio (1970), the spot in the forewing cell (underside) may or may not be present in *glandon* and its subspecies (e.g. *zuellichi* Hemming). At the same time, this spot is present in all specimens of *pyrenaicus* ever seen in collections or figured in the available literature. When counting all names of the specific group involved in *Agriades*, I drew attention to the fact that a specimen of "*orbitulus*" *araraticus* Gerhard (Bischoff in litt.) from Turkey, figured and described under this (patronymic?) name by Gerhard (1853), showed the lack of this spot. This may indicate the conspecificity of *araraticus* with *glandon* and, thus, the possible occurrence of this species in the Caucasus area. However, only a genitalic survey of material available from the easternmost part of Turkey can answer the question of its real taxonomic position. Except for *araraticus* with its uncertain position, all authors attribute *Agriades* of Asiatic Turkey to *dardanus* (for a review of the literature, see Kuznetsov, 1929, p. DLXXII; and De Lattin, 1950). The specimens collected in the westernmost part of Asiatic Turkey (Bursa) in 1973 by G. Hesselbarth were very different than the 'true' *dardanus* and other subspecies of *pyrenaicus*, and belong to a distinctly marked and previously undescribed subspecies.

***Agriades pyrenaicus hesselbarthi* Nekrutenko, new subspecies**
(Figs. 8–11)

General. Smallest butterfly in the group. This subspecies differs from the other three hitherto known subspecies of *A. pyrenaicus* by having no traces of the diffused submarginal spots in the hindwing cells M_3 - Cu_1 and M_2 - M_3 (venation and cell terminology after Miller, 1969) in both males and females. Veins do not differ by color from the upperside ground color. The underside ground color is grey, markings contrasting, almost as in *glandon*. The female's upperside is not powdered with blue scales. From all other subspecies of *pyrenaicus* and *glandon*, this one differs clearly by the male genitalia (Fig. 7).

Male. Length of forewing (base to tip) of holotype 10.7 mm (variation in the



Figs. 8-11. *Agriades pyrenaicus hesselbarthi* n. ssp.: 8, 9, ♂ holotype upper and undersides, Anatolia sept., prov. Bursa, Ulu-Dağ Ms., 2300 m, 17-23 July 1973, G. Hesselbarth leg; 10, 11, ♀ allotype, upper and undersides, same label data.

type series 10.4 to 11.0 mm). Upper side of both wings of vivid silvery blue color, becoming darker toward the margins. This darker zone begins on the forewing from discal spot and occupies about $\frac{1}{3}$ of the wing length; between veins it does not bear diffused patches of the ground color. At the margins, the dark color zone reaches the intensity of the female upperside ground color. Discal spot on the upper side of the forewing always contrasting, and because it lies on the area shaded with the basal diffused end of the marginal dark zone, it is rounded with a bright ring of blue ground color (not white). Fringe white, with black strokes at the end of each vein, that do not reach the outer margin. Ground color of the forewing underside rather dark, brown. The central cell spot in all specimens examined, varied in size, but was always contrasting, rounded with a white ring. Postdiscal spots complete, but not as uniform in size and shape as in other subspecies, each spot being rounded with a white ring. Submarginal spots complete, present in all wing cells. A very narrow, precise dark line goes along the outer wing margin. Underside of the hindwing brown, basally powdered with blue scales; this bluish zone rather narrow. Black markings rounded with narrow white rings. Discal spot with or without black pupil (some dark scales almost always present). Yellow submarginal lunule in the cell M_3-Cu_1 closed with black contrasting patches from basal and marginal sides; basally this cell always bears a well developed black spot.

Female. Length of forewing of allotype (base to tip) 10.8 mm (in 3 female paratypes ranges from 10.6 to 10.8 mm). Ground color of the upperside of both wings dark, brown-black. Black discal spots visible on both wings. Underside color and pattern as in male, ground color more vivid, markings developed more strongly.

Male genitalia (Fig. 7). General appearance as in all other *Agriades*. Juxta horseshoe-shaped, strongly chitinized. The tip of the upper valval lobe rounded, symmetric, head-shaped, bears about 20 teeth. The isthmus between the body of valva and the head is well expressed. This character, more than any other, shows a similarity to *A. pyrenaicus pyrenaicus*. **Female genitalia**. No diagnostic features (3 specimens dissected).

Material studied. Holotype, male, and allotype, female: Turkey in Asia, Anatolia sept., prov. Bursa, Ulu-Dağ Ms., 2300 m, 17–23 July 1973, G. Hesselbarth leg. Paratypes, 11 ♂♂, 3 ♀♀, same locality, dates and collector. Holotype, allotype and 5 ♂♂, 2 ♀♀ paratypes and genitalic slides deposited in the collection of the Kiev State University Zoological Museum. About 85 paratypes are in the collection of G. Hesselbarth (Quakenbrück, West Germany).

Because Alberti's original description of *latedisjunctus* is not informative enough to give reliable diagnostic features, and is not illustrated, I give here a detailed description of this taxon, based on specimens from the type locality, with complete synonymy and additional information regarding the type locality. This is a part of my Rhopalocera Caucasica Programme having as its aim the compilation in one source of a comprehensive and detailed analysis of the recent state, origins and zoogeographic features of the Caucasus Region butterfly fauna.

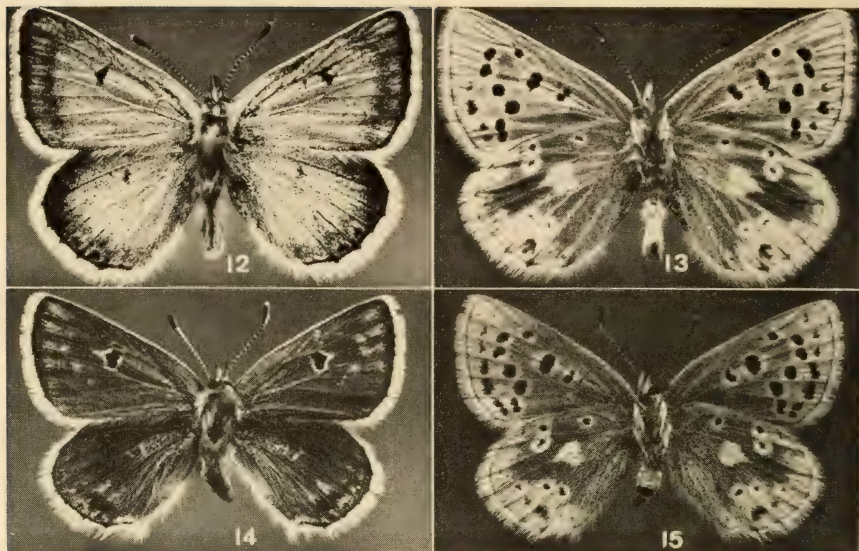
Agriades pyrenaicus latedisjunctus Alberti (1973)

(Figs. 12–15)

- Lycaena orbitulus* Prun. var. *dardanus* Frr.: Romanoff, 1884, p. 51.
L. pyrenaica var. *dardanus* Frr.: Bramson, 1890, p. 51.
L. orbitulus var. *dardanus* Frr.: Radde, 1899, p. 420.
L. pyrenaica B.: Egorov, 1903, p. 13.
L. orbitulus Prun. var. *dardanus* Frr.: Shaposhnikov, 1904, p. 206.
L. orbitulus Prun. var. *dardanus*: Alpheraky, 1907, p. 204.
L. orbitulus dardanus (?) Frr.: Riabov, 1926, p. 294.
L. orbitulus var. *dardanus* Frr.: Warnecke, 1943, p. 175.
L. orbitulus Prun. var. *dardanus* Frr.: Wojtusiak & Niesiolowski, 1947, p. 58.
L. orbitulus Prun.: Miljanowski, 1964, p. 114.
L. pyrenaica ssp. *dardanus*: Alberti, 1970, p. 123.
Polyommatus (*Agriades*) *glandon dardanus* Frr.: Korshunov, 1972, p. 363.
Lycaena pyrenaica latedisjuncta Alberti: 1973, p. 221.

General. Upperside wing color closely similar to *A. pyrenaicus pyrenaicus*, differing from *dardanus* by the more vivid, silvery blue male coloration; dark veins are clearly visible on the ground color. Differs from *pyrenaicus* and *dardanus* by the significant reduction of submarginal spots on the forewing underside, especially in males. Female's wing upperside more abundantly powdered with bright blue scales than in both *pyrenaicus* and *dardanus*. This character transitional to females of *pyrenaicus asturiensis* Oberthür. Subspecies differs from all other *pyrenaicus* ssp. by male genitalia characters (see text below and Fig. 6).

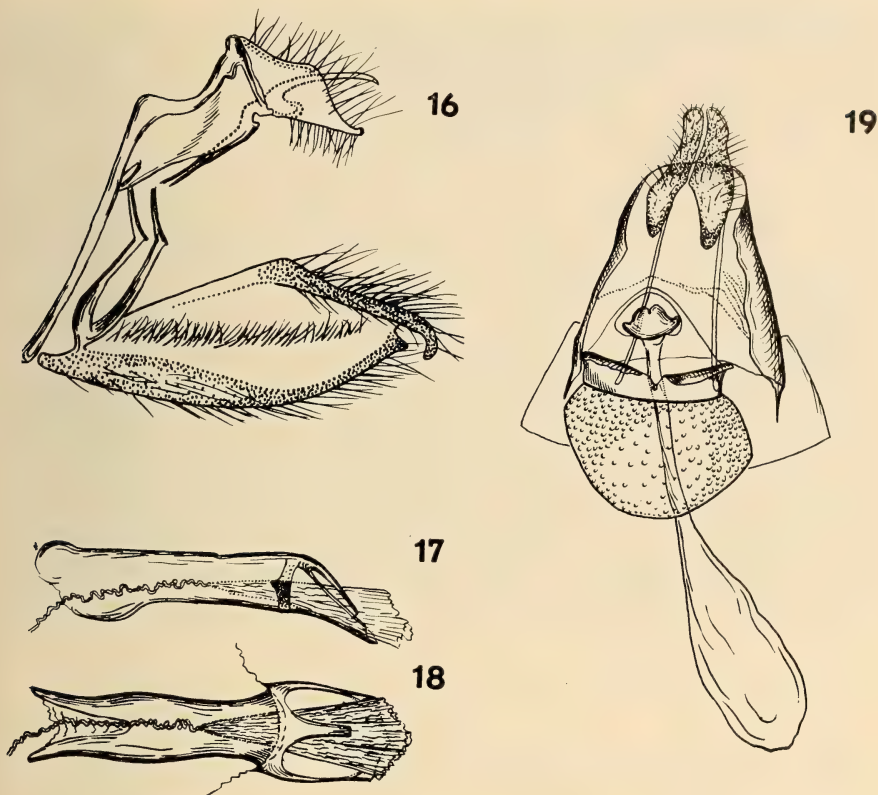
Male. Length of forewing (base to tip) 10.0 to 12.5 mm. Upperside of both wings of vivid silvery blue shining color, becoming darker toward the margins. This darker zone occupies about $\frac{1}{2}$ of the wing length, and between veins bears diffused patches of the ground color. Hindwing bears on its upperside 2 to 3 well developed diffused submarginal spots, *always* present in cells M_3 - Cu_1 and M_2 - M_3 , in some



Figs. 12-15. *Agriades pyrenaicus latedisjunctus*: 12, 13, ♂ upper and undersides, C. Caucasus, Kazbek Mt., 2900-3000 m, 26 July 1972, Y. Nekrutenko; 14, 15, ♀ upper and undersides, same label data.

specimens also in Cu_1-Cu_2 . Discal spot on the upper side of the forewing always contrasting, rounded with a white ring (weakly visible on black-and-white photographs). Fringe white, with black strokes at the end of each vein, that do not reach the outer margin. Ground color of the forewing underside bright, whitish grey, not brownish, somewhat darker toward the base and anal margin. The central cell spot in all specimens examined varies from a thin, but contrasting patch to the size of a discal spot. Postdiscal spots complete, forming S-shaped row, each spot being rounded with a white ring. Submarginal spots incomplete, toward the apical part of the forewing gradually disappearing, always present only in cells M_3-Cu_1 , Cu_1-Cu_2 and Cu_2-2A . A very narrow, precise dark line goes along the outer wing margin. Underside of hindwing bears three distinct color zones: distal, formed with confluent white postdiscal spots; medial, bright, whitish-grey; and basal, bluish grey, with metallic tint. Black markings widely ringed with white, present in cells $Sc+R_1-Rs$ (2 spots), $Rs-M_1$, M_3-Cu_1 and M_2-M_3 . Discal spot always without black pupil. Yellow submarginal lunule in M_3-Cu_1 shaded with black from basal side only; toward the margin gradually transitional into the ground color, some specimens bear a black pupil at this point.

Female. Length of forewing (base to tip) ranged from 10.0 to 12.5 mm. Ground color of the upperside of both wings dark, brown-grey. Forewing bears discal spot of deep black color, ringed with white broad circle, with characteristic drawing off toward the outer margin. Discal spots on the hindwing upperside variable: from almost complete disappearance to the size of the forewing discal spot. Hindwings bear on their upperside diffused submarginal spots as in males. Wings of many females bear bright diffused postdiscal and submarginal spots of the male color, often with greenish tint. Underside color and pattern as in male, but ground color more vivid, brownish, markings developed more strongly.



Figs. 16-19. *Agriades pyrenaicus latedisjunctus*, genitalia: 16, male, general view, aedeagus removed; 17, 18, male, aedeagus, lateral and dorsal projections; 19, female, general view, ventral projection.

Male genitalia (Figs. 6, 16-18). General appearance as in all other *Agriades*. Juxta horseshoe-shaped, with divergent upper extremities, strongly chitinized. The tip of the upper valval lobe obtuse, oblique (in *dardanus* rounded, symmetric—see Fig. 5), bears 15 to 21 teeth (20 specimens dissected). The isthmus between the body of valva and the tip broad, poorly expressed.

Female genitalia (Fig. 19). I have found no feature of diagnostic value in the female genitalic armatures in all specimens of all species of *Agriades* ever examined. The female genitalia of *latedisjunctus* are figured here to complete the description and this figure covers all *Agriades*.

Material studied. 49 ♂♂, 10 ♀♀, C. Caucasus, Georgian Soviet Socialist Republic, Kazbek Mt., 2900-3000 m, 26 July 1972 (Y. Nekrutenko); 12 ♂♂, 3 ♀♀, Kazbegi circ., 1850 m, 24 July 1972 (Y. Nekrutenko); 3 ♂♂, Abkhasia, Mzy (Mzym) Lake, 2300 m, 12 July 1972 (Y. Nekrutenko); 2 ♂♂, 1 ♀, Abkhasia, Awadhara, 2000-2200 m, July-August 1967 (E. Miljanowski); 1 ♂, Georgia, Lebarde, 8 June 1962, E. Didmanidze (coll. S. Miljanowski); 2 ♂♂, Teberda, N. W. Caucasus, July 1935, L. Sheljuzhko (Zool. Mus. Kiev Univ.); 4 ♂♂, 3 ♀♀, Daghestan,



Fig. 20. *Agriades pyrenaicus latedisjunctus*, type locality. Upper alpine zone on the Eastern slope of Kazbek Mt. at an elevation of 2900–3000 m.

Levashi, June 1926, M. Riabov (Zool. Mus. Kiev Univ.); 2 ♂♂, Tskhra-Tskaro, Borzhomi, Caucasus Minor, 2520 m, July 1914, L. Sheljuzhko (Zool. Mus. Kiev Univ.); 1 ♂, Armenia, Amamly (subalpine zone), 20 July 1925, M. Riabov (Zool. Mus. Kiev Univ.); 1 ♂, Armenia, Alagöz Mt., 15 May (?) 1935, B. Tkatchukov (Zool. Mus. Kiev Univ.).

Type locality (Fig. 20). In addition to the data given by Alberti (1973), the type locality should be restricted to the area on the Eastern slope of the Kazbek Mt., where the butterflies are most abundant. This place is situated between the Tsminda Sameba (St. Trinity) church over the Gergeti village and the Gergetskiy glacier tongue margin and fore moraine. It is in an hour or two of rather easy climbing from the Georgian Military Highway at Gergeti village, on the left bank of Terek river. In the Kazbegi village vicinity on the opposite side of Terek (1850–1900 m) the butterfly is rather scarce.

ACKNOWLEDGMENTS

I wish to acknowledge the generous help I received from Mr. T. G. Howarth of the British Museum (Natural History), and from Dr. W. Forster of the Zoologische Sammlung des Bayerischen Staates in Munich, who supplied me with many literary sources from their libraries. Mr. Gerhard Hesselbarth collected and kindly forwarded material, including the type series, of the new subspecies named here in his honor; comparative materials have been obtained from Dr. F. Fernández-Rubio, Dr.

Hans Malicky and Mr. Colin W. Wyatt. I am grateful to Dr. Tamara Zrazhevskaya for the use of her microscopical facilities. Drafts of this paper have been discussed with Mr. Yuri P. Korshunov (Novosibirsk) and Dr. Eugene S. Miljanowski (Sukhumi). My thanks are due to Dr. Theodore D. Sargent who corrected and edited the manuscript.

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RESISTANCE IN BUTTERFLY FOODPLANTS

Plant resistance to insect attack has been studied largely in connection with agricultural practices and crop plant breeding (Beck 1965, Ann. Rev. Entomol. 10: 207-232), although the principles gained therefrom should apply to natural situations as well. Butterfly larval foodplants in the wild likewise have probably developed strains that are resistant to attack. This fact would account for spotty or discontinuous distributions of some species, although the effect would be difficult to distinguish from extinction due to other causes. In the field, one frequently encounters areas where a known foodplant is present but the butterfly is absent. E.g., *Papilio indra fordii* Comstock & Martin feeds on *Cymopterus panamintensis* Coult. & Rose but not on the subspecies *acutifolius* (Coult. & Rose) Munz (Shields, Emmel, & Breedlove 1969, J. Res. Lepid. 8: 21-36). Toxic secondary plant substances may act as repellents; ecdysone or juvenile hormone or their analogues in plants may protect them from attack (Fraenkel 1969, Entomol. Exp. Appl. 12: 473-486; Hsiao 1969, Entomol. Exp. Appl. 12: 777-788). Plant resistance can disturb the insect's normal behavior, growth, and survival (Beck, 1965).

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A PROPOSAL FOR THE UNIFORM TREATMENT OF INFRASUBSPECIFIC VARIATION BY LEPIDOPTERISTS

John H. Masters' very thought-provoking and controversial paper under the above title (1972, *J. Lepid. Soc.* 26: 249-260) cannot be allowed to pass without comment. In the first place I consider it utterly wrong for any section of entomologists, be they lepidopterists, coleopterists, dipterists or any other, to attempt to formulate a code that would apply to their own Order only. Any such code must apply to all Orders of insects. Nor do I think it right that the requirements of the geneticists should be dismissed in such a cavalier fashion.

It would, perhaps, be most convenient if I listed my comments under the same headings as used in the original article.

INFRASUBSPECIFIC VARIATION (p. 250). Masters writes, "Other than a general agreement that infrasubspecific names should not be placed in italics. . . ." But is this true? It certainly is not for the four British entomological journals to which I subscribe, and the British Museum (Natural History) continues to print infrasubspecific names in italics in its *Bulletin* (Entomology). Again, is it true to say, "there has been a very sharp decline in the publication of formal names to apply to infrasubspecific varieties in the last twenty years," and, "most authors are content to describe examples of infrasubspecific variations without attempting formally to name them"? The first may be partially true, probably because most of the well marked variations have already been described and named, but in my opinion, the second is not, and, in any case, what is the point of a description without attaching a name to it? Which is the more preferable title for a hypothetical article, 'The genetics of *Arctia caja* L. and its form. . . .' or 'The genetics of *Arctia caja* L. and its form as described in 1970, Entomologist, . . . : . . .' I know which I would prefer, and I think the majority of entomologists would agree with me. I have covered the question of Lepidopterists 'going it alone' in my introductory remarks.

POLYCHROMATIC OR POLYMORPHIC FORMS (p. 250-253). Whilst Ford's definition of polymorphism is undoubtedly scientifically correct, it does appear to reduce the proportion of the rarer to the commoner form to far below what is normally considered as polymorphism. Surely there must be a point, well illustrated by Industrial Melanism in Britain, when a form ceases to be a mere mutant and becomes polymorphic. To take the geometer *Biston betularia* L. and its black form *carbonaria* Dbl. as an example, in the late eighteen hundreds and early in the twentieth century the black form was a great rarity, possibly so rare that it could not be maintained except by recurrent mutation, chiefly because its colour made it overconspicuous when at rest and it suffered heavily from predators. Once industrial pollution had altered the environment, the position was reversed and it was the typical speckled form that was at a disadvantage and, as a result, the black form, which was genetically dominant, rapidly increased its proportion of the total population until it is the prevalent form in many areas today.

Whilst there is some point in applying a *nomen collectivum* to all the forms in a group that are a manifestation of the same gene, it must not be forgotten that what may appear to be similar forms, even in the same species, may be the result of completely different genes. Whilst accepting the *nomen collectivum* in limited cases, I think there is still a need for a formal name for the various forms, and I also consider that the addition of the author's name is essential, not, as Mr. Masters points out, as a compliment to the author but to pinpoint the reference.

The suggestion of applying the model's name prefixed by pseudo- to the various forms of polymorphic mimics is only a partial solution of the problem. How, for example, are the four forms of *Danaus chrysippus* L., viz. *chrysippus* L., *alcippus* Cr., *dorippus* Klug and *albinus* Lanz, to be treated and what about the many examples of polymorphism in procrystic moths, such as *Achaea lienardi* Bsd., A.

praestans Mab., *Blenina quadripuncta* Hamps. and *Odontodes aleuca* Guen., to name only a few. Here, again, formal names seem to be the only answer.

Many aberrations in the genus *Parnassius*, the Lycaenidae and Arctiidae are almost certainly multifactorial in origin and, overlapping as they do, are probably best treated with descriptive, as opposed to formal, names. The use of descriptive terms for aberrations was probably carried to the extreme in Bright & Leeds *Monograph of the British Aberrations of the Chalk Hill Blue Butterfly, Lysandra coridon* (Poda) 1761. (Bournemouth 1938) which described some four hundred types of aberration.

MUTANT OR ABERRATIONAL FORMS (p. 253-254). The reference to the effect of cold on the pupae of *Euphydryas phaeton* (Drury) raises an interesting point. Normally the effect of unusual temperatures is an interference with the normal process of pigmentation, and Haggett (1952, Entomologist) has shewn that a number of the named forms of *Rhodometra sacraria* L. are the result of low temperatures on the pupa, examples carrying the factor for redness producing f. *sanguinaria* Esper at slightly lower temperatures and f. *rosea* Oberthur at the lowest possible, whilst those without the factor for redness produce f. *labda* Cr. at slightly lower temperatures and f. *atrifasciaria* Stephens at the lowest possible. In other words the visible effect of the gene is enhanced by low temperatures, probably through the greater length of the pupal period. In the arctiid *Panaxia dominula* L., it has been established that there are certain genes that do not manifest themselves unless the pupa is exposed to abnormally low temperatures. Whilst I agree that purely temperature forms are not worthy of a name, I do think there is a case for naming forms which are a combination of temperature and a specific gene.

I cannot agree with Masters' statement, "Whether genetic or non-genetic in cause, aberrants are not normally an integral part of any population, each specimen is an individual without direct connection with any succeeding individual that may resemble it." This is manifestly not correct in the case of genetical aberrants, even if the gene is fully dominant and lethal when homozygous it will survive unless the heterozygotes are at such a disadvantage that all are killed by predators, and a rare and recessive gene can survive undetected for generations in heterozygotes. An illustration of this occurred here recently, three specimens of an aberration of *Charaxes brutus* Cr., lacking the chestnut component of the underside basal markings, were trapped in the same area and within a few days of each other and were fairly obviously the progeny of one female. It is only a matter of time before a pairing between two apparently normal individuals, but both heterozygous for this particular gene, occurs and the aberration re-appears.

I agree that gynandromorphs, somatic mosaics and other freaks are best left unnamed, but it must not be forgotten that many of these are genetic in origin.

SEASONAL FORMS (p. 254-255). Here is one of the few parts of the paper with which I am in partial agreement. I say 'partial' as I do not care for Masters' third, and preferred, alternative. I feel that the second is by far the best. Numerals or letters to denote seasonal forms rather break down when applied to wet and dry forms in the tropics, a wet form may occur earlier in the year in one part of a species' range and later in another.

HYBRIDS (p. 255-256). Here again I am only in partial agreement. Whilst accepting the first three classes and the method of naming them, I feel that once a stable hybrid population has established itself in nature it is far preferable to give it a name and treat it as a species, for that is undoubtedly what it will become, if not sooner then later. *Papilio kahli* Chermock & Chermock may be a fairly straightforward case, but Warren's hybrid *Pieris*, based mainly on deformed andraconia, is very much a matter of opinion and is unlikely, in my opinion, ever to be proved conclusively. After all, many so-called subspecies are probably nothing more than hybrids between two separate subspecies that have met and then become isolated.

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AN ATTEMPTED INTERFAMILIAL MATING
(LYCAENIDAE—NYMPHALIDAE)

Recent reports of an attempted interfamilial mating (Shapiro 1973, J. Lepid. Soc. 27: 159) and an interfamilial courtship (Shapiro 1972, J. Res. Lepid. 11: 197–198) suggest these may occur at least as frequently as the rare pairings and courtships of sympatric congeners, which have received some attention in the literature (Downey 1962, J. Lepid. Soc. 16: 235–237). Another recent study of butterfly mating behavior (Scott 1972 [1973], J. Res. Lepid. 11: 99–127) has provided welcome data for verifying such attempts at copulation by behavioral traits. The purpose of this note is to report another attempted interfamilial mating—♂ *Lycaena phlaeas americana* Harris (Lycaenidae) and ♀ *Phyciodes tharos tharos* (Drury) (Nymphalidae)—and to comment on its significance.

The instance occurred between 1522 and 1528 hrs. on a lawn in New Paltz (Ulster County), New York, on 17 September 1973. While observing mating behavior of a number of *P. tharos* at this site, I particularly noticed one pair attempting copulation atop a clump of grass. It was a fresh female *P. tharos* and fresh male *L. phlaeas*. The latter was approximately 8 mm smaller in expanse than the former. The male, in the characteristic position behind and facing the same direction as the female, made repeated attempts at genital contact by arching its abdomen beneath and to (what appeared to be) both sides. The female remained docile, wings horizontal except for a slow, occasional fanning to an angle of about 30 or 40 degrees. The male held its wings at a 45 degree angle throughout. Having no success at contact, the male moved forward until its head and forelegs were atop the female's abdomen. This apparently startled the female, which flew lazily away to a site about 1.5 m away. The male followed, slowly, and similar behavior ensued at the second site. For an unapparent reason the female then flew to a third site, very near the first. The male followed, but this time became quite pugnacious and upon aggressively approaching the female caused her to fly off quickly. The male was unable to follow and was collected for sexual verification.

These species are phenotypically similar: both exhibit predominantly orange and black wing characters, mostly in "spotted" patterns, and males of both species are usually smaller than the female, as in the case of this attempted pairing. Further, both species seek mates by "patrolling" (Scott, loc. cit.). The female *P. tharos* was apparently receptive, displaying none of the rejection postures known to butterflies, but exhibiting instead the stationary and "basking" behaviors often mentioned as receptive traits (Scott, loc. cit.). She flew off only after notable pugnacity on the part of the male, a fact which may be doubly significant since both species are noted for this aggressive trait (Klots 1951, A Field Guide To The Butterflies, Houghton Mifflin, Boston).

Females of *Lycaena helloides* (Boisduval) reportedly fan their wings as a receptive trait (Shapiro 1973, loc. cit.), and if *L. phlaeas* females do likewise, this might have encouraged the male *L. phlaeas*' advances. Two attempted matings of *L. phlaeas* were noted at the same locality at 1540 and 1600 hrs. Characteristic of these was apparent rejection behavior by the female (wings closed tightly above the thorax, and a quick "waddling" through the grass) and extreme pugnacity by the male (following quickly behind, trying to "steer" the female into an appropriate mating position). All of these observations support the conclusion that the *P. tharos* female and *L. phlaeas* male noted above were attempting copulation.

Scott (loc. cit.) states that coloration, movement, and size are important to the visual components of butterfly mating. Shapiro (1972, 1973, loc. cit.) notes the evident importance of phenotypic similarities (and also pheromones) in eliciting such mating mistakes. He discusses the surprising phenotypic dissimilarities of his interfamilial "mates." As with his species, the pheromones of *P. tharos* and *L. phlaeas* have not been studied. If eventual pheromone data do not indicate other-

wise, this attempted mating of *L. phlaeas* and *P. tharos* may represent a more "classic" example of similar phenotypes eliciting an attempted interfamilial mating—the type which would seem most probable if such events do occur more frequently than lepidopterists have suspected.

I would like to thank Br. (Dr.) Adam McCoy, Holy Cross, for editorial assistance.

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TORTYRA SLOSSONIA COLLECTED AT UV LIGHT ON KEY LARGO, FLORIDA (GLYPHIPTERYGIDAE)

Glyphipterygid moths are diurnal and usually associated with blooming plants favored by the particular species, in addition to their hostplant. Reports of glyphipterygids at lights are as infrequent as for other diurnal insects and only *Tortyra slossonia* (Fernald), *Choreutis carduiella* Kearfott, and a *Glyphipteryx* sp. have been sparingly encountered this way, in addition to what is tentatively identified as *Choreutis leucobasis* Fernald. These Florida reports, however, involve only one or two individuals at a time, as do light collection records of *Anthophila pariana* (Clerck) from the Northeast. The *T. slossonia* records are mainly from light trap collections made by Mrs. Spencer Kemp on Key Largo and also involve only one or two specimens some nights.

Collections of diurnal insects at light have been attributed to the fact that the light has been set up near the resting place of the insect which moves to the light upon being disturbed. The large number (70+) of *Tortyra slossonia* collected at a blacklight near Tavernier, Key Largo, the evening of 20 June 1973 from about 2000 to 2300 hours indicates that it may be nocturnally active unlike other glyphipterygids. Two nights earlier on the north end of Key Largo, about 12 *T. slossonia* moths were also taken at a blacklight.

(Florida Agricultural Experiment Station Journal Series No. 5275.)

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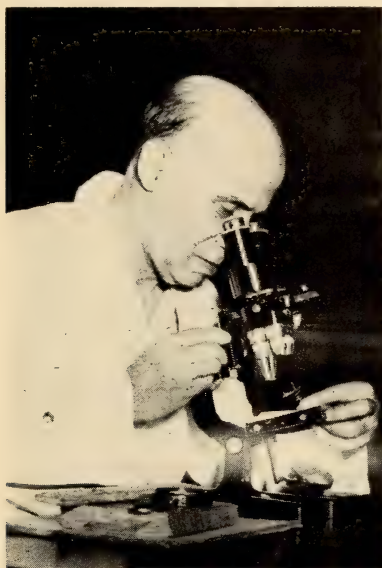
URANIA FULGENS (URANIDAE) CAPTURED IN FLORIDA

A worn male specimen of the neotropical day-flying moth, *Urania fulgens* Walk. (Uranidae), was captured by V. J. Farkas in downtown Fort Walton Beach, along Santa Rosa Sound, on the Gulf of Mexico side of northern Florida, at 1400 hrs. on 9 September 1973. It was hovering over a lantana bush in a weedy summer-cottage area. A common migratory species in Yucatan and mainland Mexico, this specimen was probably blown northeast to Florida by tropical storm "Delia" which passed over the Yucatan Peninsula around 5 September and then continued into the Gulf. This appears to be a new record for Florida (not listed in Kimball, 1965, *Lepidoptera of Florida*, Florida Department of Agriculture) and for the eastern United States.

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OBITUARY
ROMUALDO FERREIRA D'ALMEIDA (1891-1969)



Romualdo Ferreira d'Almeida, son of Henrique Ferreira de Almeida and Izabel Pereira de Almeida, was born in Rio de Janeiro on 12 February 1891 and died there on 24 August 1969. He married Aida Moreira dos Santos and had four sons, Nelson, Nysio, Newton and Ney.

His life-long interest in butterflies started at an early age, as did his interest in music which he inherited from his father. His first earnings, which he soon spent on his collection, were frequently made by playing the organ in church.

Needing to have a reliable source of income, he applied for government service and was accepted as an assistant cleaner to the Director General of Post Offices on 15 February 1917. Three years later he was made a second class cleaner and on 14 April 1921 he was promoted to delivering mail, in a third class capacity; he was promoted to the second class on 24 December 1934.

He thus worked every afternoon in order to have a reliable, if modest, source of income, and left the mornings free to dedicate himself to his passionate interest. His collection, at first very small due to lack of space and working conditions, and done without any outside help whatsoever, grew slowly. Because of his lack of support in Brazil, he

started corresponding with entomologists in other countries, first in France and Germany and later throughout the world. In Brazil he remained unrecognized and rejected by all the research institutions which he contacted, until a friend of his, Sr. J. Pinto, a photographer at the Oswaldo Cruz Institute in Rio de Janeiro, introduced him to Dr. Lauro Pereira Travassos, also of the Oswaldo Cruz Institute, in 1933. Despite having 24 publications in French and German, Romualdo F. d'Almeida had been ignored for 20 years. Dr. Travassos, a specialist in helminths and Lepidoptera, soon realized that he was dealing with someone worthy of recognition, and thus, with the support of the influential deputy, Arthur Neiva, arranged for Romualdo F. d'Almeida to deliver the mail within the Oswaldo Cruz Institute. Here, with good working conditions, equipment, a specialized library, and a suitable atmosphere to work in, he was able to improve and increase his output. He gave up delivering mail. Here he wrote his largest and best-known works, the revisions of the genus *Eurema* (Pieridae), the genus *Actinote* (Nymphalidae) in the southeast of Brazil, and on the family Danaidae; he also worked out his plans for the research that he was to do throughout his life. From this time on, Romualdo F. d'Almeida was recognized and respected in Brazil.

In 1937, he had the opportunity of accompanying the border Commission (northern sector), led by Commander Braz Dias de Aguiar, when an outstanding collection of butterflies was made in the area of the Cuminá and Trombetas rivers in Pará. Another important expedition, made only shortly before he died, was to the Amapá Territory in 1967; this was at his own expense and he spent all of the small amount of money which he possessed.

He remained at the Oswaldo Cruz Institute until 1 December 1940, officially delivering letters but in practice studying butterflies. From 2 December on, at the invitation of Dr. Salvador de Toledo Piza, he was appointed as an assistant in the Zoology Department of the Secretary of Agriculture, Industry and Commerce for the State of São Paulo, and was thus under the directorship of Dr. Oliverio Pinto. This was the first time that he had been employed as a research worker. Here, not having a collection, with which he would have been much happier, his research was mainly bibliographical, including various aspects of nomenclature. He remained there until 4 July 1944, when he was transferred to an appointment as Assistant Naturalist at the Ministry of Education and Health, at the initiative of the director of the National Museum of Rio de Janeiro, Dr. Heloisa Alberto Torres.

On his return to Rio, he was able to go back to working on his own

the Societé Linean de Lyon; L'Union de Entomologiste Belges; Internationaler Entomologischer Verein, Frankfurt; and the Sociedade Brasileira de Entomologia, which dedicated a book to him in 1945. In 1950, Romualdo Ferreira d'Almeida was awarded the medal of the "Oficial da Ordem Nacional do Merito" by Getulio Vargas, the President of Brazil, and later received the medal from President Eurico Gaspar Dutra.

I am grateful to Dr. Judith Smith of Universidade Federal do Paraná, who kindly translated the text from Portuguese to English.

PROF. OLAF MIELKE, *Univ. Fed. Parana, Curitiba, Parana, Brazil.*

EUREMA PROTERPIA (PIERIDAE) IN KANSAS

A female specimen of the Tailed Sulphur, *Eurema proterpia* Fabr., was taken seated on wild aster blossoms in a field near Rantoul Gap, nine miles east of Ottawa in Franklin County, Kansas, on 15 October 1973. I netted the specimen just a few feet away from a specimen of the Mexican Snout Butterfly, *Libytheana carinenta* (Cramer) which was also seated on the asters. Neither butterfly has ever been recorded in Kansas before and I presume both of them to be new state records (although *carinenta* was taken by the dozens in this area during the autumn of 1971). Both specimens were somewhat worn and are presumed to have been migrants entering the region from farther south. Both specimens will be deposited in the Los Angeles County Museum at Exposition Park, Los Angeles, California.

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JOURNAL

of the

LEPIDOPTERISTS' SOCIETY

Published quarterly by THE LEPIDOPTERISTS' SOCIETY

Publié par LA SOCIÉTÉ DES LÉPIDOPTÉRISTES

Herausgegeben von DER GESELLSCHAFT DER LEPIDOPTEROLOGEN

Publicado por LA SOCIEDAD DE LOS LEPIDOPTERISTAS



27 December 1974

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Memoirs of the Lepidopterists' Society, No. 1 (Feb. 1964)

A SYNONYMIC LIST OF THE NEARCTIC RHOPALOCERA

by CYRIL F. DOS PASSOS

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JOURNAL OF THE LEPIDOPTERISTS' SOCIETY

Volume 28

1974

Number 4

A NEW SPECIES OF THE GENUS *SEMIOTHISA* FROM THE SOUTHEASTERN UNITED STATES (GEOMETRIDAE)

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Moths identified as *Semiothisa* (or *Philobia*) *aemulataria* (Walker) in most collections from the southeastern United States were found to be a mixture of two species of extremely similar appearance. One of these is the true *aemulataria*; the other is undescribed. *Semiothisa aemulataria* is common in collections and widely distributed, occurring across southern Canada from Newfoundland to Alberta and southward to the Gulf States, including northern Florida and eastern Texas. Southern specimens tend to be smaller, darker, and less clearly marked than northern ones, but I found no structural differences and continue to regard such variants as belonging to the same species.

The undescribed species that has been confused with *aemulataria* is somewhat larger, generally paler than southern examples of *aemulataria* from the same region, and with the markings more boldly defined, especially the intense, red-brown postmedial bands on the undersides of both wings. The heavily swollen (incrassated) hind tibia of the male (Fig. 14) at once distinguishes it from all of the North American species of *Semiothisa* Hübner formerly placed in *Philobia* Duponchel (*aemulataria* (Walker), and *versitata*, *perplexata*, *aspirata* and *ulsterata* (Pearsall)). The widely sympatric *Semiothisa aequiferaria* (Walker), often confused with *aemulataria* in the South, also has a swollen male hind tibia, but the moth is smaller and darker, with the outer margin of the forewing less obviously notched behind the apex. The new species, which I am naming *Semiothisa promiscuata*, occurs from Maryland to Florida, and west to Illinois, Arkansas and eastern Texas. Its hostplant and early stages are unknown.

Semiothisa aemulataria was described as *Macaria aemulataria* Walker (1861: 884) from one male and one female in the British Museum



Figs. 1-6. Specimens: (1) *Semiothisa promiscuata*, n.sp., holotype; (2) same specimen, underside; (3) *S. promiscuata*, allotype; (4) same specimen, underside; (5) *S. aemulataria* (Wlk) ♂, Bog E of Big Indian L., Halifax watershed area, Nova Scotia, 27 June 1963, underside; (6) *S. aemulataria* ♀, District of Columbia (no date), underside. Photos by Smithsonian Institution Photographic Laboratory.

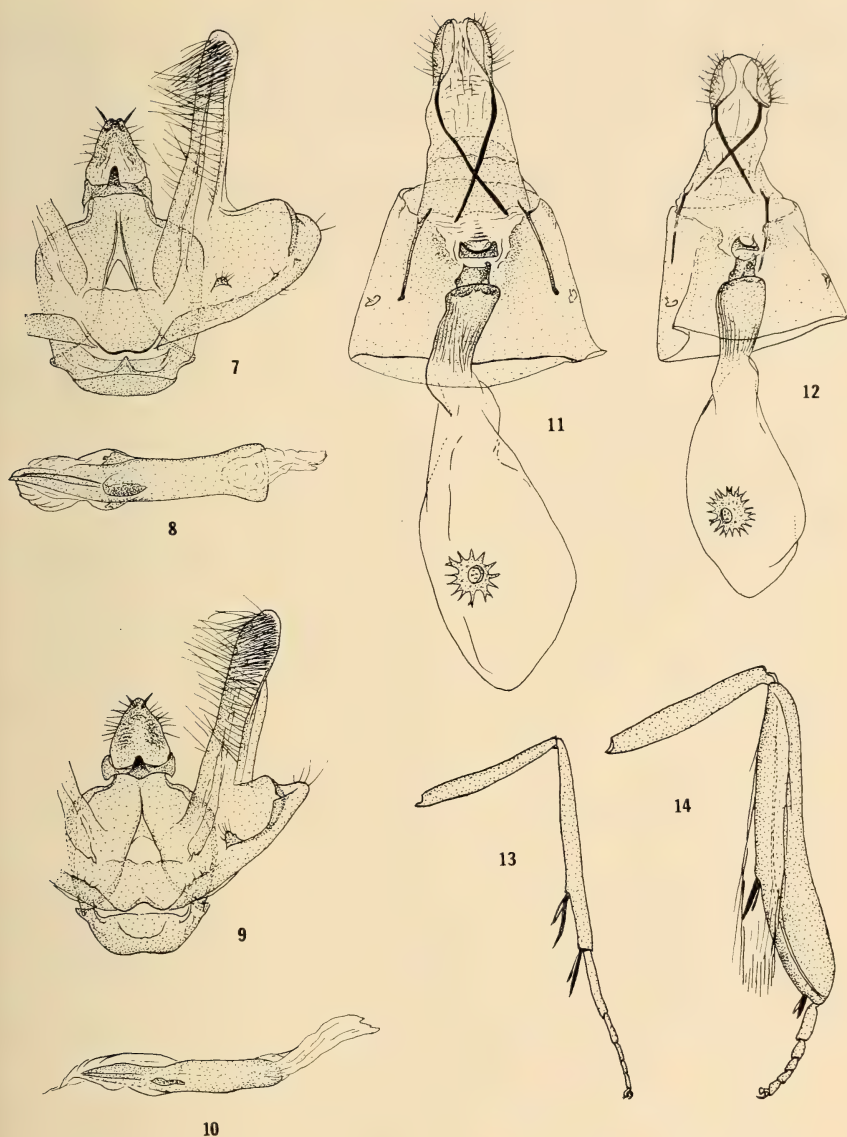
(Natural History) from New York and "East Florida." I hereby designate as the lectotype the male, presumed to have been taken at Trenton Falls, Oneida Co., New York, and it is being so labelled. I have not seen this specimen, but in his description of it Walker said, "hind tibiae hardly incrassated." This precludes any possibility that it refers to the new species herein described. Also, the type locality as restricted is almost certainly too far north for this new species.

The only recognized synonym of *S. aemulataria* is *Macaria sectomaculata* Morrison (1874: 198), based on an unstated number of specimens from Massachusetts and New York. I have not seen the types, but again it would seem certain that their source is north of the range of *S. promiscuata*.

***Semiothisa promiscuata*, Ferguson, new species**

Figs. 1-4, 7, 8, 11, 14

Description. General coloring, pattern of upperside, and wing shape almost exactly as in *S. aemulataria*, although whitish areas of wings appear a little more lustrous and translucent, and size somewhat larger, more nearly comparable to the northern *S. ulsterata*. Outer margin of forewing distinctly emarginate just behind apex, this concavity with a blackish, crescent-shaped lining. **Upperside of forewing** with antemedial and medial lines light brown, weak, nearly perpendicular to inner margin except angled basad just before costa; postmedial line parallel to these but expanded intermittently to form a series of dark brown to blackish spots, especially near middle of wing; postmedial bounded outwardly by a thin, pale line, and beyond this by an incomplete postmedial band of larger dark spots concentrated in two patches, as follows: a group of 3 large blackish spots in the middle of the wing, trisected by pale veins (M_3 and Cu_1), closely adjacent to the mesial spots of the



Figs. 7-14. Genitalia and hind legs: (7) ♂ genitalia of *S. promiscuata*, Plummers Island, Maryland, 17 August 1971; (8) aedeagus of same specimen; (9) ♂ genitalia of *S. aemulataria*, Raleigh, North Carolina, 29 April 1970; (10) aedeagus of same specimen; (11) ♀ genitalia of *S. promiscuata*, Raleigh, North Carolina, 13 July 1969; (12) ♀ genitalia of *S. aemulataria*, Montgomery Co., Maryland, 25 May 1900; (13) right hind leg of *S. aemulataria*, Plummers Island, Maryland; (14) right hind leg of *S. promiscuata*, Jackson, Mississippi. Drawings by the author.

postmedial line, and a still more closely unified, subquadrate group of 2 or 3 spots at the costa, very thinly bisected by R_5 or trisected by R_5 and M_1 , and browner than the nearly black mesial group. **Upperside of hindwing** with antemedial and postmedial lines light brown, weak, irregular, the latter marked by several blackish points on the veins; small dark discal spot present; outer third of hindwing evenly brownish, contrasting with paler medial and basal areas, and with less tendency to be banded with lighter and darker shades than in *aemulataria*. **Underside** whitish, dusted with reddish-brown scales; small discal spots on both wings; lines corresponding to those of upperside present or absent, often vague, irregular; however, immediately distad of the thin, wavy postmedial there is a much wider, straight or slightly curved and uninterrupted reddish-brown band on both wings, thinner but much more intensely colored than that of *aemulataria*.

Length of forewing: Holotype male, 13 mm; other males, 12–13 mm; allotype female, 13 mm; other females, 12.5–15 mm.

Head and body similar in the two species, including series of black dorsal markings on the abdomen and structure of antennae, palpi and legs, except that the male hind tibia of *promiscuata* (Fig. 14) is elongated and greatly swollen, forming the sheath for a large expansible hair tuft recessed into an almost full-length, longitudinal groove on its posterior side. In Fig. 14 the tuft is shown partly extruded. Male hind tibia of *aemulataria* (Fig. 13) hardly swollen at all and apparently lacking the hair tuft. Hind tarsus of *promiscuata* shorter than that of *aemulataria*.

Male genitalia (Figs. 7, 8) most similar to those of *aemulataria* and its closest relatives, but differ in the following characters: ventral lobe of valve very broad and rounded at apex; elevated, bladelike ridge near apex on ventral surface of this lobe consisting mainly of a single component in *promiscuata*, of two separate components in *aemulataria* (Fig. 9); ventral margin of juxta straight or only slightly concave in *promiscuata*, clearly emarginate in *aemulataria*; tooth on gnathos and two spines on uncus slightly longer; sclerotized band on vesica (seen as a folded structure inside aedeagus) about twice as large in *promiscuata* (Figs. 8, 10). **Female genitalia** larger than those of *aemulataria*; structures associated with ostial opening enlarged and more heavily sclerotized (Figs. 11, 12).

Types. **Holotype** ♂ (Figs. 1, 2), Devil's Den State Park, Washington Co., Arkansas, 1 July 1966, R. W. Hodges, USNM Type No. 73059. **Allotype** ♀, Raleigh, North Carolina, 17 June 1970, H. H. Neunzig. **Paratypes:** 1♂, 1♀, Plummers Island [Montgomery Co.], Maryland, 17, 5 August 1971, D. R. Davis; 1♀, Glen Echo [Bethesda], Maryland, June 1914; 1♀, Lathrop, Maryland, 23 June 1955, E. C. Becker; 1♀, District of Columbia, 4 June 1902; 2♀♀, Raleigh, North Carolina, 1 June 1970, 13 July 1969, H. H. Neunzig; 6♂♂, 2♀♀, Morehead, Kentucky, 3, 8, 19 July, 21, 29 August, 8 September 1962–63, T. N. Freeman; 1♀, Renfro Valley, Kentucky, 18 July 1955; 1♀, Valley Station, Kentucky, 29 August 1973, A. J. Brownell; 1♀, Homer Bird Sanctuary, Oldham Co., Kentucky, 6 September 1972, C. V. Covell, Jr.; 1♀, Elkhart, Illinois, "Aug. 1–7"; 1♀, McClellanville, South Carolina, 30 August 1973, R. B. Dominick; 1♀, Emory University, Georgia, "8-10-46," H. V. Weems, Jr.; 1♀, Screven Co., Georgia, 8 July 1946, Otto Buchholz; 2♀♀, Gainesville, Florida, 14 May 1970, 9 July 1972, F. W. Mead; 1♂, Alachua Co., Florida, 8 April 1959, J. Perry; 2♂♂, 1♀, Torreya State Park, Liberty Co., Florida, 23 May 1966, G. W. Rawson; 1♀, Greenville, Mississippi, "8-09," G. Dorner; 1♂, Jackson, Hinds Co., Mississippi, 4 June 1960, Bryant Mather; 1♂, Town Bluff, Tyler Co., Texas, 27 March 1963, A. & M. E. Blanchard; 1♂, Conroe, Montgomery Co., Texas, 14 May 1967, A. & M. E. Blanchard. The type material is in the collections of the U.S. National Museum; the American Museum of Natural History; the Biosystematics Research Institute, Canada Department of Agriculture, Ottawa; the Division of Plant Industry of the Florida Department of Agriculture, Gainesville; Mr.

André Blanchard; Dr. C. V. Covell, Jr.; Dr. R. B. Dominick; Mr. C. P. Kimball; and Mr. Bryant Mather.

Remarks. I have also seen 3 specimens regarded as too poor to include in the type series. These are as follows: 1♀, Montgomery Co., Virginia, 1 June 1901; 1♀, Renfro Valley, Kentucky, 25 May 1955; 1♀, Quincy, Gadsden Co., Florida, 8 November 1966.

Semiothisa promiscuata superficially resembles *S. regulata* (F.) of Central and South America, but the genitalia of the latter species are very different, more so than those of *aemulataria* or any of the closely related North American species. The greatly enlarged, swollen, male hind tibia is generally characteristic of the genus *Semiothisa*, and the members of the *aemulataria* group (*Philobia*) are unusual in not having the hind leg modified in this way.

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WALKER, F. 1861. List of the Specimens of Lepidopterous Insects in the Collection of the British Museum 23: 753-1020.
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A FURTHER NOTE ON THE ACCEPTABILITY OF AN ALTERNATE FOODPLANT FOR *HEMILEUCA MAIA* (DRURY) (SATURNIIDAE)

Information to verify the acceptability of foodplants other than *Quercus* for *Hemileuca maia* Drury was given by Smith (1974, J. Lepid. Soc. 28: 142-145). The author mentions the successful rearing of *maia* on a species of *Salix* (willow) in 1972, from Albany Co., New York livestock collected on scrub oak, and supplied by me. That same year, using some of the ova from the egg mass sent to Capt. Smith, I reared *maia* on *Salix* (weeping willow). The larvae were fed on this foodplant from the beginning, not transferred to it after having been started on *Quercus*, as in the case of Capt. Smith's program. My adults, too, emerged in September the same year, and were exceptionally large specimens.

IRWIN LEEUW, 1219 Crystal Lake Road, Cary, Illinois 60013.

ETHMIA BIPUNCTELLA IN MARYLAND, PENNSYLVANIA AND
WEST VIRGINIA: THE EXPANDING RANGE OF AN
INTRODUCED EUROPEAN MOTH
(GELECHIOIDEA)¹

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Ethmia bipunctella (Fabricius) has been introduced from Europe into North America and during the past decade has become widely established in the northeastern United States and southeastern Canada (Powell, 1973: 103). The earliest records are July 1964, on the St. Lawrence River in northern New York, and August 1964, in New Jersey at the mouth of the Hudson River. Subsequent published records are available from the Ottawa and Montreal areas in 1965, Connecticut in 1967, and central New York in 1970 (Powell, 1973). More recently accumulated collections include localities in Maryland, Pennsylvania and West Virginia, indicating that the adventive distribution is steadily expanding.

In 1971 (after the above literature report was in press) specimens of *E. bipunctella* were sent to the U.S. National Museum of Natural History for identification from Maryland and Pennsylvania localities. K. C. Kim informed us (in litt.) that the earliest record for the latter state in the Pennsylvania State University collection is Chambersburg, Franklin Co., in July 1970 (R. R. Kline, coll.), while the U.S.N.M. has specimens from the same locality collected in May 1971 and from Friendship, Anne Arundel Co., Maryland in August 1970. Kim also reported that this alien moth was taken in several counties of Pennsylvania for the first time during 1973 (Penn. Cooperative Insect Report for 21 September 1973). The data are as follows: *Franklin Co.*—Letterkenny Army Depot, IV-19 (3 moths), IV-27 (18), V-4 (33), V-16 (5), V-11 (6), V-20 (5), VI-11 (7), VI-18 (3), VI-29 (1), VII-9 (9), VII-16 (3), VII-27 (6), VII-30 (11); *Dauphin Co.*—Harrisburg-York Internatl. Airport, VII-25 (5); *Erie Co.*—Erie Marine Terminal, VIII-9 (2); *Centre Co.*—State College, IX-16 (1), and Ferguson Township, IV-22 (1) (D. L. Beirlein, U.S.N.M.).

¹ Florida Agricultural Experiment Station Journal Series No. 5274.

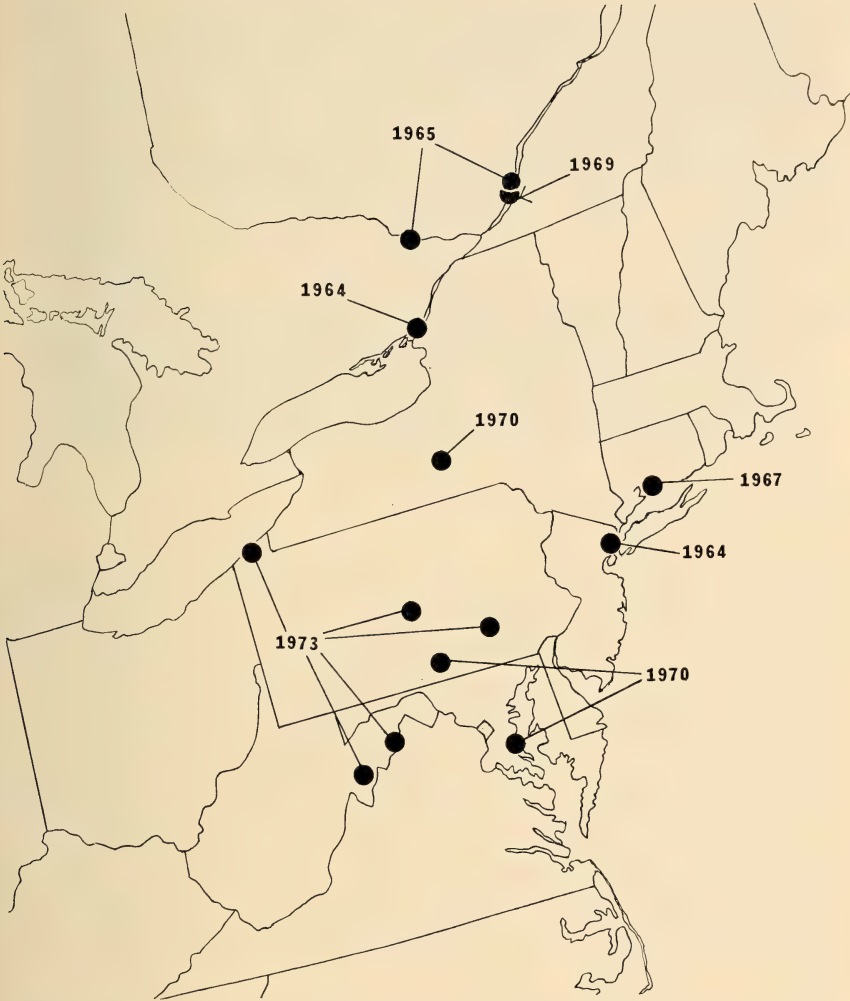


Fig. 1. Spatial distribution of *Ethmia bipunctella* in eastern North America. Earliest known year of occurrence at each locality is given.

Single males were taken by Heppner at two sites in northeastern West Virginia on 1 and 2 September 1973. The first was captured at Hawk Campground near Capon Springs, Hampshire County and the second about 21 km. north of Franklin, Pendleton County. Both appeared to be freshly emerged specimens.



Fig. 2. *Ethmia bipunctella*, male, dorsal view (collected at Ottawa, Ontario, Canada, 2 August 1965 by H. F. Howden).

Fig. 1 summarizes North American records by earliest year of capture, indicating the general outward movement from Atlantic Coast and St. Lawrence River points of possible introduction. The 1973 records from Pennsylvania and West Virginia show a continuing range extension westward and south along the Appalachian Mountains. Inasmuch as well-documented distribution changes are potentially useful in analyzing evolutionary phenomena, we encourage lepidopterists to be on the watch for colonies of this moth. The adult (Fig. 2) cannot be confused with any native species of the eastern Nearctic. The forewings are contrastingly black and white and the abdomen is bright ochreous. When at rest the moths are about 12–15 mm in length; spread specimens range 21–28 mm in expanse. Nearly all collections have been made at blacklights.

Ethmia bipunctella is bivoltine in Europe, flying from June to July and in September. In southern parts of its distribution in the Old World and in American colonist populations, the generation pattern is not clear. Capture records from Pennsylvania in particular suggest a well-defined spring flight from late April to late May and a sporadic emergence through the summer months that might involve a partial third generation.

Foodplant records in Europe include *Echium vulgare* (Boraginaceae), an introduced weed that is widespread in North America, as well as members of three other Holarctic genera of Boraginaceae. Probably any

native plants of this family that grow in appropriate habitats could be used by adventive populations of the moth.

ACKNOWLEDGMENTS

We thank R. W. Hodges, ARS, U.S. National Museum of Natural History, and K. C. Kim, Department of Entomology, Pennsylvania State University, for providing records from the collections of their respective institutions.

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TWO NEW THECLA FROM THE CONTINENTAL UNITED STATES (LYCAENIDAE)

This brief note reports the findings of two hairstreaks which represent notable additions to the Nearctic region. The first of the two is previously unlisted (Dos Passos 1964, *Lepid. Soc. Mem.* No. 1; Dos Passos 1970, *J. Lepid. Soc.*, 24(1):26-38) and was called to my attention last fall by a colleague who received one specimen from Mr. Wayne Klopp from the Miami, Florida area. Photographs were subsequently taken and submitted to Dr. F. Martin Brown, Colorado Springs, Colorado for determination. The butterfly was identified as *Electrostrymon angelica angelica* Hewitson, the nominate subspecies found in Cuba. In addition to the 4 original specimens of this species taken by Mr. Klopp in August 1973, he located a large population just south of Miami in January 1974. Mr. Richard Anderson, formerly of Key West, Florida also found the species in some numbers in that area in the latter part of 1973.

The second species of interest here is *Chlorostrymon simaethus* (Drury) collected by Mr. Klopp and his wife Carol on Key Largo, Florida during February 1974. Previous distributional data for this species include only continental land areas from South America northward to southern portions of Texas, Arizona, and California (Clench 1961, in Ehrlich & Ehrlich, *How to Know the Butterflies*, Brown, Dubuque, Iowa, p. 189). It is therefore unreported from any Antillean area, the origin of many species taken sporadically in southern Florida. Whether this is an oversight in the distribution or whether it has been overlooked in that region and actually represents an undescribed subspecies is under investigation. The author has no neotropical *C. simaethus* for comparison. The Florida insect is significantly distinguishable from *C. simaethus sarita* (Skinner) from the U.S. It is expected that other new and interesting species will turn up in the southern Florida area from year to year and that collectors should keep an eye out for them, particularly the smaller, less conspicuous species. (Thanks to Dr. F. M. Brown for the determination for *E. angelica* and Mr. Wayne W. Klopp for examples of both species discussed.)

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ED. NOTE: This note, and the article by R. A. Anderson in this issue, both include a report of the occurrence of *Electrostrymon angelica angelica* in Florida. For the record, the manuscript of Anderson was received on 8 March 1974, and that of Fisher on 30 April 1974.

NOTES ON THE LIFE CYCLE AND NATURAL HISTORY
OF BUTTERFLIES OF EL SALVADOR. IV. *ANAEA*
(*MEMPHIS*) *EURYPYLE CONFUSA* (NYMPHALIDAE)

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This is the fourth article of a series dealing with what my sons and I have found in relation to the life cycle and natural history of Rhopalocera inhabiting the vicinity of San Salvador, capital of the republic of El Salvador. The first part of the series presents the subfamily Charaxinae of the family Nymphalidae. It started with *Prepona omphale octavia* Frühstorfer, followed by *Anaea* (*Zaretis*) *itys* Cramer and *Anaea* (*Consul*) *fabius* Cramer. After the present article, another on the life cycle of *Anaea* (*Memphis*) *morvus boisduvali* Comstock will continue the series. We undertook these investigations with the intent of presenting the life cycles, the foodplants, and observations on the behavior of the early stages and adults of the local species of Rhopalocera. There is little of this information in the available literature, and this applies in particular to the Charaxinae of Tropical America. Comstock (1961) states, ". . . there is surprisingly little to be found in the literature concerning the ova, larvae and pupae of the butterflies that have been discussed." (the genus *Anaea*). Consequently the classification of this group has been based exclusively on morphological characteristics of the adults, which is not the ideal situation as implied in the following statement by Ford (1945), "Any classification must take into account as many as possible of the external and internal structures not only of the adults but of the early stages." It is our hope that our articles, and the early stages which we have preserved in alcohol and placed in a Museum so as to be available for students of the groups, will help in this regard. The butterflies mentioned in this article were identified by Dr. Lee D. Miller of the Allyn Museum of Entomology, where the specimens of the early stages have been placed.

Anaea (*Memphis*) *eurypyle confusa* Hall was named *Anaea ryphea* by Godman and Salvin, in 1884, but was renamed by Hall in 1929. In order to have an idea of the habitat of this species in this country, refer to the first article of the series on *Prepona omphale octavia* (Muyshondt, 1973). In short, *A. (M.) eurypyle confusa* is a denizen of coffee plantations and their neighborhood, where it is often seen feeding on decaying fruits or on animal and human excreta, either in the middle of the

plantations or in the roads that cross them. Its habitat is therefore limited to the altitudes in which coffee is planted locally, from about 700–2000 m. The foodplant is widely used in wind-break barriers and as live fence posts in coffee plantations.

We have bred the species for a number of years now, and the results have been the same with small variations. Photographs have been made of the eggs, the different stadia, the pupae and the adults, both male and female. Records of development time have been kept, and specimens of the early stages have been preserved in alcohol and sent to the Allyn Museum of Entomology. The reared material was kept during development in transparent plastic bags under ambient lighting and temperature conditions.

Life Cycle Stages

Egg. Translucent white with greenish tinge, about 1 mm diameter, with flattened base and depression at micropyle. No sculpturing noticeable at 10× magnification. Hatch in 5 days.

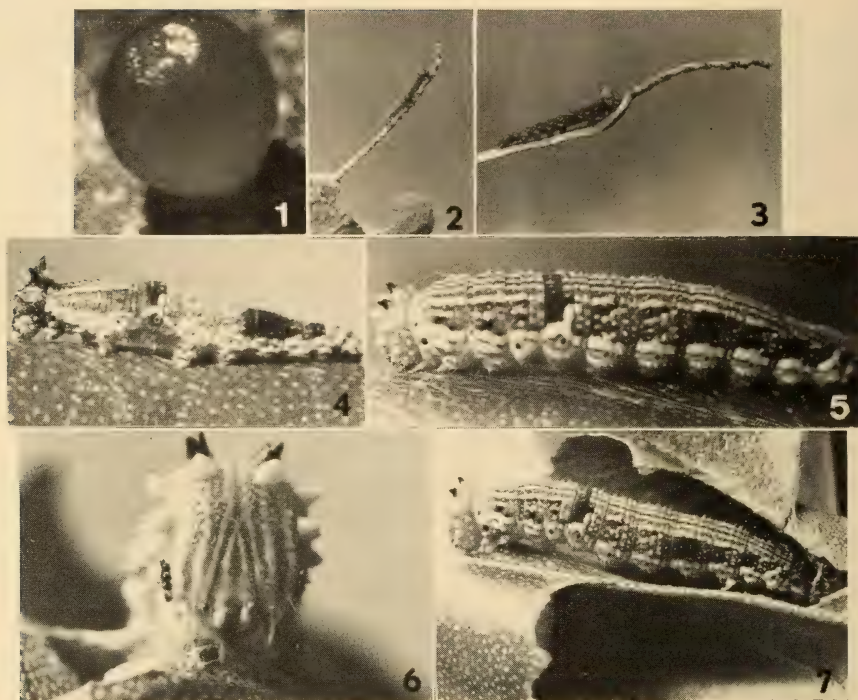
First instar larva. Head light brown, naked, roundish, with slight cleft between epicrania. Body light greenish brown, naked, with annulets between segments, 2.5 mm at emergence, around 5 mm when ready to moult. Duration 5 days.

Second instar larva. Head light brown with rudimentary horns over epicrania, and several whitish tubercles scattered mostly at sides of epicrania. Black ocelli. Body greenish brown with rings of very tiny white tubercles, three per segment. Whitish tubercles along subspiracular zone. Body thicker at second abdominal segment, tapering to first thoracic segment and to last abdominal segment. Measures 0.9–1 cm before moulting. Duration 3–5 days.

Third instar larva. Head brown with short black horns on epicrania. Black vertical lines in frontal area. Scattering of white tubercles, more prominent at sides of head. Body greenish brown with white tubercles as in second instar. Spiracula dark brown surrounded by whitish ring, the first thoracic being larger than any other and the eighth abdominal larger than the rest. Spiracula on second and eighth abdominal segments are slightly higher than the others. Body thickens from first thoracic segment to second abdominal segment, which is surrounded by a dark band, and tapers then to caudal end. Dark lateral patches at fifth and seventh abdominal segments. Measures 1.7–1.9 cm before moulting. Duration 4–5 days.

Fourth instar larva. Head dark brown to black with yellowish vertical lines in frontal area, stubby black horns on epicrania, and many prominent yellow tubercles, mostly at sides of epicrania and around horns. Body as in third stadium, with dark band along dorsal meson, more whitish tubercles along subspiracular area and across caudal segments, and additional lateral dark patches at third thoracic, first and sixth abdominal segments. Measures 3.2–3.4 cm before moulting. Duration 5–7 days.

Fifth instar larva. Head greenish with jet black stubby horns and very prominent yellow tubercles around horns and at side of epicrania; alternate greenish and yellow vertical lines in frontal area, those in center reaching between horns, the rest diminishing gradually to sides of head. Black ocelli contrasting with yellow bordering line. Body green with lighter stripes dorsally from head to caudal end, and transverse rows of whitish small tubercles; spiracula contrasting over whitish patches forming an irregular band subspiracularly. Body now thicker than head, and dark patches of fourth stadium now reddish. Scarce scattering of black tubercles notice-



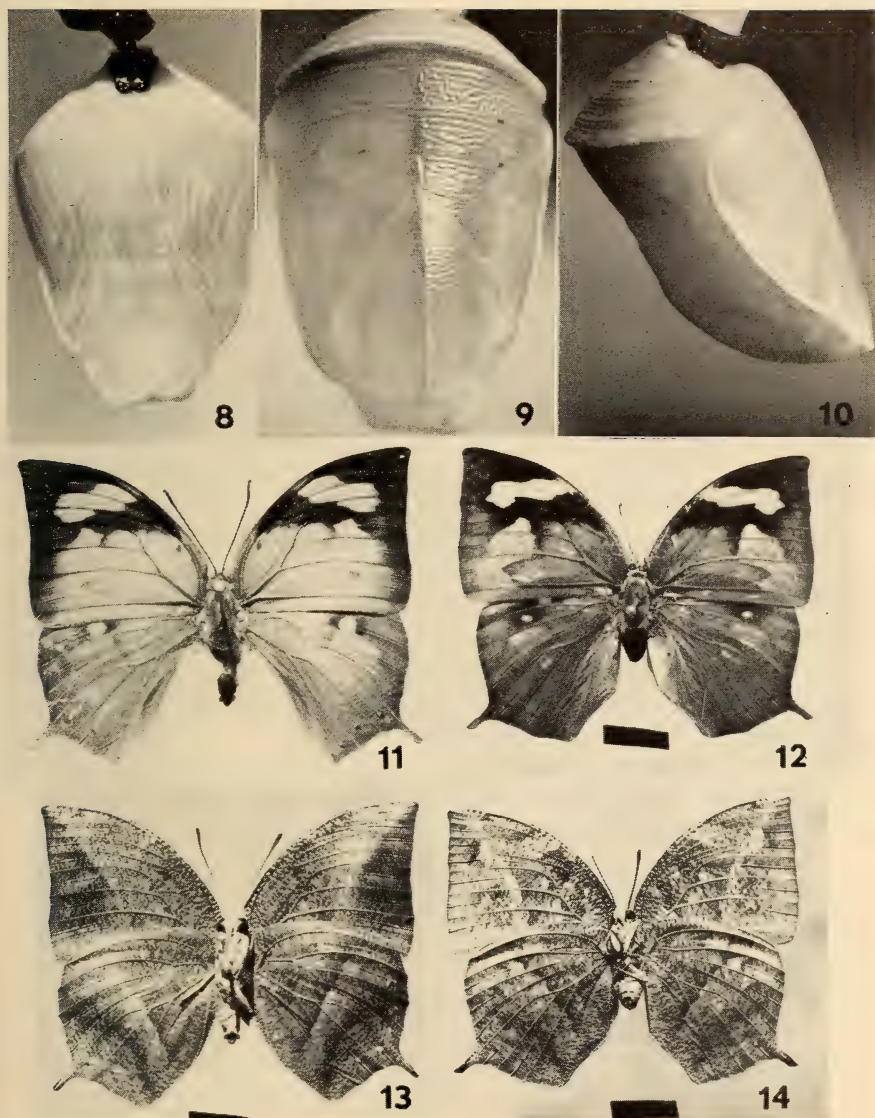
Figs. 1-7. *Anaea (Memphis) eurypyle confusa* Hall: (1) egg, about 1 mm; (2) first instar larva on perch, about 3 mm; (3) second instar larva recently moulted, about 6 mm; (4) fourth instar larva, about 2.5 cm; (5) fifth instar larva, about 4.5 cm; (6) close-up of head, fifth instar; (7) fifth instar larva re-entering partially opened funnel, note silk padding inside.

able mostly along subspiracular zone. Measures, before entering prepupal stage, 4.5-5 cm. Duration 9-11 days.

Prepupa. Body shortens considerably and appears thicker, loses colorations of fifth stadium and now all light green, with the whitish small tubercles, bigger black spots and spiracula prominent. Stays incurvated laterally, not hanging, for one day.

Pupa. Light green or light brown, with yellowish ridge bordering wing cases and across fourth abdominal segment. Cremaster black and very elaborate at base. Abdomen tapers abruptly from fourth segment to cremaster, and very gradually towards slightly bifid head. Thoracic segments keeled dorsally. Spiracula yellowish, very inconspicuous. Measures about 1.5 cm long, 0.9-1 cm dorsoventrally at thickest point, and 0.8-0.9 laterally at widest point. Duration 8-11 days.

Adult. Both sexes same shape, with minor variations occurring even between individuals of same sex. Forewing more-or-less acute at apex, the outer margin more-or-less concave just below the apex, then more-or-less convex to tornus, and inner margin straight. Hindwing rounded with short tail at vein M3, anal angle not pronounced and with a discolored fold at inner margin. Color follows the same pattern in both sexes, being more vivid in the male, and very dull in the female. Dorsally, dominant color orange with dark brown apically; brown extending along costal and outer margins, leaving elongated orange patch subapically. In the male,



Figs. 8-14. *Anaea (Memphis) eurypyle confusa* Hall: (8-10) pupa—ventral, dorsal and side view; (11) male, dorsal view; (12) female, dorsal view; (13) male, ventral view; (14) female, ventral view. Black bars 1 cm.

dark brown zone has bluish reflection. On hindwings, orange covers whole surface except for inner margin fold that is somewhat decolorated, and two lighter rounded spots about middle of costal margin. Row of dots alongside outer margin submarginally from tail to anal angle. Ventrally both wings, in both sexes, dark grayish

brown. Females usually larger than males; average, from tip to tip of spread forewings, 5.5 cm in female, and 5.0 cm in male. Total developmental time from 40–45 days.

Natural History

During the five years we have been observing and rearing this species we have seen the females lay eggs on two species of *Croton* (Euphorbiaceae): *C. reflexifolius* H. B. K., and, more rarely, *C. niveus* Jacquin. These species are very similar, and are known by the common name, Copalchí. The most apparent difference is that the fruits of *C. reflexifolius* are muricated, but are not in *C. niveus*. Both species grow to small tree size (about 6 m) and both are used commonly to form wind-break barriers in coffee plantations (due to their thick foliage) and for fence supports. The leaves and bark of both species are very aromatic and bitter, and are widely used in popular medicines as infusions against fevers and to aromatize alcoholic beverages. Both species keep their leaves year around.

We have found in the literature (Planchon & Collin, 1895) the following on *C. niveus*: "J. Elliot Howard a signalé dans cette écorce une matière amère soluble dans l'éther, qui au contact du chlore et de l'amoniaque prend une teinte vert foncé. Moench n'a pu y constater la présence d'un alcaloïde; il en a seulement retiré une huile essentielle constituée par un hydrocarbure, un acide organique et un principe amer cristallisable, la *Copalchine*, soluble dans l'alcool et le chloroforme." Calderón y Standley (1941) state about *C. reflexifolius*, "La hojas y frutas son muy aromáticas; las hojas utilizadas en la confección de algunos aguardientes; la corteza como febrífugo y remedio tónico."

The recently emerged larvae completely devour the egg shell and stay under the leaf without further eating for about one day, moving afterwards to the border of the leaf, usually to the tip, where they choose a terminal vein which they eat around and bare. Using excreta stuck with silk they prolong the vein and use this as a resting place while not feeding, the head usually pointing outward. The larvae during the first, second and third stadia abandon this perch only for feeding purposes. During the fourth stadium the larvae wander about the plant for a short time until they select a bigger leaf, where they form a funnel-like refuge by rolling the leaf with the help of silk to crawl back into. From then until pupation the larvae keep hiding inside this funnel, leaving it momentarily only for feeding, which is done at dawn and dusk. The thick and tubercled head is very effective in blocking the entrance against any predator or injection-parasite. The excrements are expelled through the narrow end of the funnel.

When ready to pupate, the larvae abandon their hiding place and wander about the plant until a suitable place is located. This is usually the underside of a leaf or twig, where they weave a silken pad to which they affix their annal prolegs, and stay incurvated sideways, not hanging, for one day during which time they expel a greenish liquid mixed with excreta, and then pupate.

All through the larval stages *A. (M.) euryppyle confusa* seems very apathetic. When prodded with a thin brush the larvae merely extrude a gland located between the prothoracic legs and emit a pungent scent. If the proding is continued, the larvae turn around, and make biting motions.

The pupae are rather stiff and make only limited lateral movements when molested. The color of the pupae is either light green or light brown regardless of environmental conditions and of sex. Both morphs can be found simultaneously at any time of the year. The same phenomenon occurs in other species of *Anaea*, as well as in other Nymphalidae and Brassolidae (e.g. *Dynamine* spp., *Opsiphanes tamarindi* Felder, and *O. cassina fabricii* Bdv. (Muyschondt, 1973)).

The adults of *A. (M.) e. confusa*, both male and female, are very swift flyers, like most Charaxinae we have observed in this country (with the exceptions of *A. (Consul) fabius* and *A. (C.) electra* Westwood), producing while in flight a rustling noise somewhat like Hesperidae. Only the females when ovipositing fly slower. The female rapidly approaches a Copalchí plant, and then circles around it more slowly, until alighting under a leaf of medium development, and depositing a single egg on the undersurface of it, somewhere in the middle. She then resumes the circling around the plant and repeats the process several times before flying away. We have witnessed cases in which the female has oviposited up to six eggs without respite, at different levels on the same plant. Females are usually seen ovipositing late in the morning or early in the afternoon. Both sexes are assiduous visitors of decaying fruits and animal excrements, where they feed for long periods until gorged. When this happens, it is rather easy to net them. We have never seen this species feeding at flowers. The habitat of the species is restricted to coffee plantations and neighboring ravines. That means that the species is found only from an altitude of about 700 m up to around 2000 m, as coffee is not planted in El Salvador below or over these limits.

Up to the present we have never been able to observe this species in courtship or while mating; in fact, we have never observed the courtship and mating behavior of any Charaxinae. After so much time spent in the field observing this and other Charaxinae without witnessing some

sexual activity, we must assume that members of this subfamily are very secretive about these behaviors.

Females dissected three days after emergence, have no eggs in their abdomen. It is not unusual to collect eggs that never hatch, and at times some eggs produce tiny wasps (*Chalcidoidea*). Quite often larvae of this species are affected by a sort of diarrhea that kills them, or by a disease that softens their body tissues until they burst.

DISCUSSION

Comstock (1961) implies that nothing has been published up to now relating to the life cycle and behavior of the early stages of *Anaea* (*Memphis*) *eurypyle confusa*.

As expected, the eggs of this species resemble very closely in shape all the eggs of the species of *Charaxinae* we have been able to rear, even to the color (with the exception of *A. (Zaretis) itys* whose color is translucent yellow, instead of translucent greenish-white). Furthermore, the shape and habits of the larvae are very similar to those of *A. (C.) fabius*, *A. (C.) electra* and *A. (Memphis) pithyusa* R. Felder; and the pupa is quite hard to tell from that of *A. (Z.) itys*, *A. (C.) fabius* and *A. (C.) electra*, though not resembling the pupa of other species classified under the *Memphis* group of the genus *Anaea* that we have reared, such as *A. (M.) pithyusa* and *A. (M.) morvus boisduvali*.

The wing shape of the adults of this species shows small variations in both sexes, even among individuals emerged during the same month. The behavior, flight and habitat are like those of adults of *Anaea (Memphis) pithyusa*, with whom they share even the foodplant.

Like other *Charaxinae*, the first three stadia of *Anaea (M.) eurypyle confusa* rely for protection on their ability to imitate portions of leaf tissue left alongside a bared vein, while the fourth and fifth stadia hide within a funnel-like construction they make in a chosen leaf, and emit a strong odor when molested. In the funnel, the hidden larva regurgitates an amount of green liquid that floods the inside of the funnel and runs out of both ends. As the foodplant has strong aromatic and bitter properties, it is probable that this liquid has repellent qualities for the enemies of the larva, and most probably the larva itself is protected by an unpalatable flavor derived from the foodplant. These defense mechanisms have proved to be very effective against "injection-parasites" at least, for during the eight years we have been rearing this species in our insectary, we have not found a single case of this type of parasitism. The protection the species has acquired against injection-parasitism does not work however against "ingestion-parasites," such as the *Tachinidae* that

lay their eggs on the leaf where the larvae are feeding. The amount of larvae killed by Tachinidae, in our experience, reaches an estimated 40%. The tachinid larvae usually abandon the victim during the fifth stadium or just after pupation.

The adults of *A. (M.) e. confusa* also exhibit a combined defense mechanism: rapid flight with flash-and-hide effect, caused by the orange coloration on the dorsal surface of the wings and the cryptic grayish-brown coloration on the ventral side; and this cryptic coloration that mimics the color of a dry leaf, rendering the adults very inconspicuous among vegetation (or when they are sitting on surfaces such as tree trunks, where they even adopt a slanted position to minimize the shadow they project, according to the sun situation). The only time adults are vulnerable to predation (if they are not protected by unpalatable properties, as we strongly suspect), is during their feeding sessions, when they seem to get so engorged as to lose their habitual alertness.

Taking as a basis the developmental time of 40–45 days under laboratory conditions, this species could produce about eight generations a year due to the fact that the foodplant remains well covered by succulent leaves the year around. In fact adults and larvae of the species can be collected at any time of the year.

A very vulnerable stage in the life cycle of this species appears to be the egg stage. For some undetermined reason a considerable number of eggs never hatch, and some of them produce a tiny Chalcidoidea (which has been sent to the U.S. Dept. of Agriculture for determination).

As said for *Prepona omphale octavia* (Muyshondt, 1973), this is one of the few species of Rhopalocera that has derived benefits from man-made changes in the natural ecology, i.e. by the agumentation of the foodplant in coffee plantations.

ACKNOWLEDGMENTS

We are greatly indebted to Miguel Serrano and Stephen Steinhauser for sharing with us their personal observations on the adults of this species and for giving us free access to their technical libraries; and to Drs. Lee D. Miller and Theodore D. Sargent for finding time in their crowded schedules to read the manuscripts and give constructive criticism. Special mention must go to the enthusiasm of Albert, Jr. and Pierre, two members of the family, who have made most of the findings on the early stages of this species. Specimens of the early stages have been sent to Allyn Museum of Entomology.

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NOTES AND NEWS

I wish to thank the many persons who provided assistance to me during this last year of my editorship. The members of the Editorial Committee of the Journal were most helpful as primary reviewers of submitted manuscripts. In addition, the following individuals reviewed one or more manuscripts upon request: L. P. Brower, H. A. Freeman, D. F. Owen, D. F. Schweitzer, and A. M. Stuart. I extend my grateful thanks for all of this help.

My wife, Katherine, kindly provided the cover drawing (*Paonias excaecatus* Smith & Abbot), and aided in many other ways. Susan M. Moore served as an editorial assistant, and helped particularly by preparing the index. Finally, I wish every success to my successor.

THEODORE D. SARGENT

LIST OF FOODPLANTS OF SOME EAST AFRICAN
RHOPALOCERA, WITH NOTES ON THE EARLY STAGES
OF SOME LYCAENIDAE

V. G. L. VAN SOMEREN

Karen, Kenya

During the course of some fifty-odd years of intermittent field work in Uganda and Kenya, I have gleaned a small amount of knowledge regarding the foodplants of the butterflies of the two territories.

The list, in its present form, is compiled at the request of Dr. F. H. Rindge of the American Museum of Natural History, New York. It deals with some 300 species out of the 2000 known to occur in eastern Africa. I hope that the list, however incomplete, will be of some use to students of this fascinating branch of the study of Rhopalocera of East Africa.

The distribution of species is closely related to the known range of their foodplants. It will be noted that species which are common and widespread have a multiplicity of foodplants belonging to several botanical families, thus contributing to their chance of survival despite the rapid changes in environment now going on in these territories as a result of the increase in areas under cultivation and concurrent destruction of indigenous forests.

I am indebted to the following for help in determining the botanical material: the Director of the Kew Herbarium, through the good services of the late Professor Poulton of Oxford; to Dr. P. G. Greenway, at one time in charge of the Herbarium at the Amani Research Station, Tanzania, and later Botanist in charge of the East African Herbarium, Nairobi; and to Dr. B. Verdcourt, also of the East African Herbarium.

It is regretted that, in some instances, the material submitted was inadequate for specific identification, and is here listed with a query. In some instances, the name supplied originally is now considered to be a synonym, and the corrections have been made wherever possible.

For the majority of records, the butterfly was reared from egg to imago on the foodplant selected by the female parent.

PART 1. FOODPLANTS

PAPILIONIDAE

Papilio dardanus Brown, eastern subspecies. Rutaceae: *Teclea simplicifolia* (Engl.) Verdorn (= *viridis* Verdorn); *T. nobilis* Delile; *T. stuhlmanni* Engler; *T. villosa* N. R. F. Tayler; *Toddalia asiatica* Lamarck; *Vespris eugenifolia* (Engl.) Verdorn; citrus, various exotic.

- P. phorcas* Cramer, and subspecies. Rutaceae: *Teclea simplicifolia* Verdorn; *T. nobilis* Delile; *T. villosa* Tayler.
- P. mackinnoni* E. Sharpe, and subspecies. Rutaceae: *Teclea simplicifolia* Verdorn; *T. nobilis* Delile; *T. tricarpa* Engler.
- P. nobilis* Rogenheimer, and subspecies. Canaceae: *Warburgia ugandensis* Sprague.
- P. lormerei* Distant. Rutaceae: *Clausena anisata* (Wild) Oliver; *Fagaropsis* sp.; *Teclea* spp.
- P. ophidicephalus* Oberthur. Rutaceae: *Clausena anisata* (Wild) Oliver; *C. inaequalis* Benth.
- P. constantinus* Ward, and subspecies. Rutaceae: *Clausena* spp.; *Teclea* spp.
- P. hesperus* Westwood. Lauraceae: *Tylostemon ugandensis* (Rendle) Staf.
- P. rex* Oberthur, and subspecies. Rutaceae: *Teclea tricarpa* Engler; *T. stuhlmanni* Engler (?).
- P. demodacus* Esperance. Rutaceae: *Caledendron capensis* Thunberg; *Clausena anisata* Wild (Oliver); *C. inaequalis* Benth.; *Fagaropsis angolensis* Dale; citrus, exotic; *Toddalia asiatica* Lamarck. Anacardiaceae: *Pseudospondias microcarpa* Engler.
- P. nireus* Linnaeus, and subspecies. Rutaceae: *Caledendron capensis* Thunberg; *Toddalia asiatica* Lamarck; *Clausena* spp.; citrus, various exotic.
- P. bromius* Doubleday, and subspecies. Rutaceae: *Caledendron capensis* Thunberg; *Teclea* spp.
- P. magda* Gifford (= *brontes* auct.). Rutaceae: *Teclea* spp.
- P. teita* van Someren. Rutaceae: *Vespris eugeniifolia* Verdorn; *Teclea* spp.
- P. jacksoni* E. Sharpe, and subspecies. Rutaceae: *Clausena anisata* (Wild) Oliver; *C. inaequalis* Benth.
- P. echerioides* Trimen, and subspecies. Rutaceae: *Clausena inaequalis* Benth.; *Toddalia asiatica* Lamarck.
- P. cynorta* Fabricius. Rutaceae: *Clausena* spp.
- P. ugandae* Lathy. Anacardiaceae: *Pseudospondias microcarpa* Engler.
- P. leonidas* Fabricius, and subspecies. Anonaceae: *Uvaria leptocladon* Oliver; *Uvaria* sp.; *Anona senegalensis* Perse. Apocynaceae: *Landolphia ugandensis* Staph.; *L. buchannani* Engler.
- P. philonoe* Ward. Anonaceae: *Uvaria leptocladon* Oliver; *U. chamae* Beauvais.
- P. pylades* Fabricius, and subspecies. Apocynaceae: *Landolphia buchannani* Engler; *L. ugandensis* Staph. Anonaceae: *Anona senegalensis* Perse; *Anona*, exotic cultivated.
- P. polices* Cramer. Anonaceae: *Uvaria bukobensis* Engler; *U. chamae* Beauvais. Apocynaceae: *Landolphia buchannani* Engler; *L. ugandensis* Staph.
- P. antheus* Cramer, and subspecies. Apocynaceae: *Landolphia ugandensis* Staph. Anonaceae: *Anona* spp.
- P. sisenna* Mabil. Anonaceae: *Anona senegalensis* Perse.
- P. porthaon* Hewitson. Anonaceae: *Anona* spp.
- P. colonna* Ward. Anonaceae: *Anona* spp.
- P. kirbyi* Hewitson. Anonaceae: *Anona senegalensis* Perse.

PIERIDAE

- Leptosia marginea* Mabil, *wigginsii* Dixey, *hybrida somereni* Bernardi, *pseudonuptilla* Bernardi, *alcesta pseudoalcesta* Bernardi, *medusa immaculata* Aurivillius. Caparidaceae: *Capparis* spp. (small scandent shrubs in forest; thorns recurved; leaves elongate or ovate).
- Appias sylvia* Fabricius, and subspecies. Euphorbiaceae: *Drypetes ugandensis* Hutchinson; *D. gerrardi* Hutchinson (= *battiscombei* Hutchinson).

- A. lasti* Smith. Euphorbiaceae: *Drypetes gerrardi* Hutchison; *Phyllanthus* sp. indet.
A. sabina Felder, and subspecies. Euphorbiaceae: *Drypetes ugandensis* Hutchinson;
D. gerrardi Hutchinson. Capparidaceae: *Ritchia fragrans* (Sims) G. Don. (?).
A. epaphia Cramer, and subspecies. Capparidaceae: *Boscia salicifolia* Oliver; *Boscia*
spp.
Pinacopteryx eriphia Godart, and subspecies. Capparidaceae: *Boscia* spp.
Belenois zochalia Boissduval, and subspecies. Capparidaceae: *Capparis tomentosa*
Lamarck; *C. lilacinus* Gilgood; *C. albersi* Gilgood; *C. galeata* Freis.; *Maerua*
triphylla Richmond (= *cylindricarpa* Gilgood, *pubescens* Gilgood); *M. hoenelli*
Schweinfurth. Salvadoraceae: *Salvadora persica* Linnaeus.
B. margaritacea E. Sharpe. Capparidaceae: *Maerua* spp.
B. raffrayi Oberthur, and subspecies. Capparidaceae: *Capparis* spp.
B. victoria Dixey, and subspecies. Capparidaceae: *Capparis tomentosa* Lamarck;
Maerua spp.
B. calypso Druce, and subspecies. Capparidaceae: *Maerua* spp.; *Cadaba* spp.
B. subeida Felder, and subspecies. Capparidaceae: *Capparis* spp.
Anaphaeois gidica Godart. Capparidaceae: *Capparis* spp. Salvadoraceae: *Salvadora*
persica Linnaeus.
A. creone Cramer. Capparidaceae: *Capparis* spp.; *Boscia* spp.
A. aurota Fabricius. Capparidaceae: *Capparis* spp.; *Boscia* spp.
Dixeia pigea Boissduval, and subspecies. Capparidaceae: *Capparis* spp.
D. doxo Godart, and subspecies. Capparidaceae: *Capparis* spp.
D. spilleri Spiller. Capparidaceae: *Capparis* spp.
Pieris (Belenois) solilucis Butler. Capparidaceae: *Capparis tomentosa* Lamarck.
Pontia helice johnstoni Crowley. Resedaceae: *Caylusia abyssinicus* (Fresenius) Fischer.
Cruciferaeae: *Crucifera* spp.; *Epicastrum arabicum* Fischer and Meyer.
P. glaucanome Klug. Cruciferaeae: *Epicastrum arabicum* Fischer and Meyer.
Catopsilia florella Fabricius. Caesalpinaceae: *Cassia* spp. Papilionaceae: *Sesbania*
spp.
Nepheronia thallasina Boissduval. Hippocrataceae: *Hippocrates obtusifolia* Lessner.
N. argyia Fabricius. Rhizophoraceae: *Cassipura ruwenzorensis* Alsten.
N. bouqueti Butler. Capparidaceae: *Ritchea fragrans* (Sims) G. Don.; *R. albersi*
Gilger. Salvadoraceae: *Salvadora persica* Linnaeus.
Eronia leda Butler. Salvadoraceae: *Salvadora persica* Linnaeus. Capparidaceae:
Capparis tomentosa Linnaeus; *C. caleagnous* Gilger.
Myllothris sagala Smith, and subspecies. Loranthaceae: *Loranthus* spp., including
fischeri, *freisiorum*, *dredgei*, *usuinensis*, etc. In the absence of *Loranthus*, *Vis-*
cum is utilized. All are parasitic.
M. chloris Fabricius, and subspecies. Loranthaceae: most species of *Loranthus*.
Santalaceae: *Osyris abyssinicus* Hochsteter.
M. ruppelli Karsch, and subspecies. Loranthaceae: *Loranthus* spp.
M. poppea Cramer, and subspecies. Loranthaceae: *Loranthus* spp.
M. ruandana Strand. Loranthaceae: *Loranthus* spp.
M. bernice rubricosta Mabille. Polygonaceae: *Polygonum barbatum* var. *fischeri*
(= *setosulum* A. Richard), a swamp plant.
Colias electo Linnaeus. Caesalpinaceae: *Cassia* spp.; *Sesbania* spp. Oxalidaceae:
Oxalis spp.
Terias hecabe Linnaeus, and subspecies. Mimosaceae: *Albizia gummitifera* Smith;
Albizia spp.
T. brigitta Cramer, and subspecies. Caesalpinaceae: *Cassia* spp.; *Sesbania* spp.
Colotis hetaera Gerstaecker, and subspecies. Capparidaceae: *Capparis* spp.
C. regina Trimen. Capparidaceae: *Capparis* spp.; *Boscia* spp.

- C. ione* Godart. Capparidaceae: *Capparis* spp.; *Boscia* spp.
C. elgonensis E. Sharpe, and subspecies. Capparidaceae: *Maerua* spp.
C. eris Klug. Capparidaceae: *Capparis* spp.; *Ritchea* spp.
C. evarne Klug. Capparidaceae: *Capparis* spp.; *Maerua* spp.
C. incretius Butler. Capparidaceae: *Capparis* spp. Salvadoraceae: *Salvadora persica* Linnaeus.
C. achine Cramer. Capparidaceae: *Capparis* spp.; *Ritchea* spp.
C. danae Fabricius. Capparidaceae: *Capparis* spp.
C. antigone Butler. Capparidaceae: *Capparis* spp.
C. antevippe Butler. Capparidaceae: *Capparis* spp.
C. evenina Wallengren. Capparidaceae: *Capparis* spp.
C. calais amatus Fabricius. Capparidaceae: *Capparis* spp.
C. aurigineus Baker. Capparidaceae: *Capparis* spp.; *Boscia* spp.
C. vesta Reiche. Capparidaceae: *Capparis* spp.
C. phisadia rothschildi E. Sharpe. Salvadoraceae: *Salvadora persica* Linnaeus.
C. pallene rogersi Dixey. Capparidaceae: *Capparis* sp. indet.
C. venosa Strand. Capparidaceae: *Capparis* spp.
C. halimede Klug. Capparidaceae: *Capparis* spp.
C. pleione Klug. Capparidaceae: *Capparis* spp.
C. celimene Lucas. Capparidaceae: *Capparis* spp.; *Boscia* spp.

NYMPHALIDAE

- Najas* (= *Euphaedra*) *neophron* Hopffer, and subspecies. Sapindaceae: *Deinbollia borbonica* Scheffler; *D. kilimanjarica* Taubert.
N. uganda Aurivillius, and subspecies. Sapindaceae: *Deinbollia fulvotomentella* Baker; *Allophylus subcoriacius* Baker.
N. spatiosa Mabille. Sapindaceae: *Philodiscus unijugatus* Radikofer (= *zambesiacus* Baker); *Paullinia pinnata* Linnaeus.
N. medon Linnaeus. Sapindaceae: *Philodiscus unijugatus* Radikofer (= *zambesiacus* Baker); *Deinbollia fulvotomentella* Baker.
N. eleus Drury, and subspecies. Sapindaceae: *Philodiscus unijugatus* Radikofer.
N. coprates Druce, and subspecies. Sapindaceae: *Philodiscus* spp.; *Allophylus* spp.
Euryphene mardania Fabricius, and subspecies. Palmae: various palms, including *Phoenix reclinata* Jacqin; *Hyphene thebaica* Mart.; borassus palm; cultivated coconut.
Cymothoe caenis Drury, and subspecies. Flacourtiaceae: *Rawsonia usambarensis* Schaumann; *R. lucida* Harvey and Sender.
C. coranus Smith. Bignoniaceae: *Kigelia (aethiopica) africana* Benthann; *K. moosa* Sprague; *Fernandoa magnifica* Seemann.
Salamis cacta Fabricius. Urticaceae: *Utera hypselidendron* Wedd; *U. cameroonensis*.
S. temora Felder. Acanthaceae: *Paulowilhelmia sclerochiton* Lindau; *Mimulepsis spatulata*; *Justicea* spp.
S. parhassus Drury. Acanthaceae: *Asystasia schimperi* T. Anderson.
S. anacardii Linnaeus. Acanthaceae: *Asystasia schimperi* T. Anderson.
Catacroptera cloanthe Cramer. Acanthaceae: *Barlesia stuhlmanni* (?).
Precis octavia Cramer, and subspecies. Labiatae: *Coleus barbatus* Benthann; *C. umbrosus* Vatke; *Plectranthus defolius* Hochsteter; *Pycnostacys* sp.
P. westermanni Westwood. Acanthaceae: *Asystasia schimperi* T. Anderson.
P. oenone Linnaeus (= *clelia* Cramer). Acanthaceae: *Asystasia* spp.; *Barlesia stuhlmanni*.
P. hierta Fabricius (= *cebrene* Trimen). Acanthaceae: *Barlesia stuhlmanni* (?).

- P. chorimene* Guerin. Acanthaceae: *Asystasia schimperii* T. Anderson; *Justicia leikepiensis* (?).
- P. sophia* Fabricius. Acanthaceae: *Paulowilhelmia sclerochiton* Lindau.
- Pseudacraea lucretius* Cramer, and subspecies. Sapotaceae: *Chrysophyllum viridifolium* Wood (= *welwichii*); *C. albidum* G. Don.; *C. gorongosanum* Engler.
- P. boisduvalli* Doubleday, and subspecies. Sapotaceae: *Chrysophyllum viridifolium* Wood; *Manilkara bagshawii* Moore.
- P. eurytus* Linnaeus, and subspecies. Sapotaceae: *Mimosops bagshawii* Moore; *M. kummel* Hochstacher; *Chrysophyllum* spp.
- Hamanumida daedulus* Fabricius. Combretaceae: *Combretum* spp.
- Aterica galene* Brown, and subspecies. Combretaceae: *Quisqualia indica* (= *littorea* (Engler) Exell.).
- Charaxes jasius epijasius* Reichelman. Celastraceae: *Gymnosporia* spp.; *Elaeodendron* spp.; *Maytenus* spp. Gramineae: *sorghum* spp.
- C. jasius saturnus* Baker. Celastraceae: *Elaeodendron* spp. Caesalpinaceae: *Afzelia cuanzensis* Welwich; *Brachystygia spiciformis* Benthams; *B. edulis* Hutchison and Davy.
- C. jasius harrisoni* E. Sharpe. Caesalpinaceae: *Brachystygia spiciformis* Benthams.
- C. hansali* Felder, and subspecies. Salvadoraceae: *Salvadoria persica* Linnaeus.
- C. castor* Cramer, and subspecies. Celastraceae: *Maytenus senegalensis* Exall.; *Elaeodendron* spp.
- C. ansorgei* Rothschild, and subspecies. Melianthaceae: *Bersama abyssinica* Fresenius; *B. paullinoides* Verdcourt.
- C. phoebus* Butler. Melianthaceae: *Bersama abyssinica* Fresenius.
- C. pollux* Cramer, and subspecies. Sapindaceae: *Deinbollia kilimanjarica* Taubert; *D. burbonica* Schaff. Melianthaceae: *Bersama abyssinica* Fresenius. Euphorbiaceae: *Fluggea microcarpa* Blume.
- C. druceanus* Butler, and subspecies. Myrtaceae: *Syzygium caudatus* Krauss; *S. guinense* Willdenow; *S. sp. undet.*
- C. brutus* Cramer, and subspecies. Euphorbiaceae: *Fluggea microcarpa* Blume. Melianthaceae: *Bersama* spp. Tiliaceae: *Grewia* spp. Meliaceae: *Melia volkensii* Gurke; *M. azarach* (exotic); *Ekebergia capensis* Sparmann.
- C. lucretius* Cramer, and subspecies. Anonaceae: *Anona senegalensis* Perseus.
- C. violetta* Smith, and subspecies. Caesalpinaceae: *Afzelia cuanzensis* Welwich; *Brachystygia spiciformis* Benthams; *B. edulis* Hutchison and Davy. Sapindaceae: *Deinbollia kilimanjarica* Taubert.
- C. pythodorus* Hewitson, and subspecies. Papilionaceae: *Crabia brownei* Dunn; *C. laurentii* Willdenow; *C. brevicaudata* Dunn.
- C. etesipe* Godart, and subspecies. Euphorbiaceae: *Ricinus communis* Linnaeus; *Croton megalocarpa* Hutchison; *Phyllanthus meruensis* Pax; *P. guinensis* Pax; *Tragia benthamii* Pax; (= *cordifolia*). Mimosaceae: *Entada abyssinica* Richmond; *E. gigas* Fawcett and Randle; *E. scandens* (Linnaeus) Benthams. Caesalpinaceae: *Afzelia cuanzensis* Welwich. Papilionaceae: *Dalbergia microcarpa* Taub and Baker.
- C. penricei* Rothschild. Mimosaceae: *Entada* spp.
- C. achaemenes* Felder. Caesalpinaceae: *Brachystygia spiciformis* Benthams; *B. oliveri* Fawcett and Randle; *B. randii* Baker; *B. appendiculata* Benthams.
- C. guderiana* Dufrane. Caesalpinaceae: *Brachystygia spiciformis* Benthams; *B. edulis* Hutchison and Davy. Papilionaceae: *Balbergia melanoxylon* Guillemin and Perrettet.
- C. blanda kenya* Poulton. Caesalpinaceae: *Brachystygia spiciformis* Benthams; *B. edulis* Hutchison and Davy.
- C. jahlusa* Trimen, and subspecies. Mimosaceae: *Acacia* spp.

- C. baumannii* Rogenhofer, and subspecies. Mimosaceae: *Acacia pennata* Willdenow; *A. seval* Delil; *Peterolobium stellatum* Brenan (= *lacerans* R. Bruce).
- C. anticlea* Drury, and subspecies. Mimosaceae: *Acacia poetzi* Hauman; *A. pennata* Willdenow.
- C. pleione* Godart, and subspecies. Mimosaceae: *Acacia pennata* Willdenow; *Acacia* spp.
- C. paphianus* Westwood, and subspecies. Mimosaceae: *Acacia* spp.
- C. manica* Trimen, and subspecies. Mimosaceae: *Albizia antuesiana* Harmsworth. Papilionaceae: *Dalbergia nyasae* (?).
- C. fulgurata* Aurivillius. Caesalpinaceae: *Erythrophleum africana* Guillemin and Perettet.
- C. aubyni* Poulton, and subspecies. Mimosaceae: *Albizia gummifera* C. A. Smith.
- C. berkeleyi* van Someren, and subspecies. Mimosaceae: *Albizia gummifera* C. A. Smith. Rhamnaceae: *Scutia myrtina* Burmann.
- C. baileyi* van Someren. Rhamnaceae: *Scutia myrtina* Burmann.
- C. candiope* Godart. Euphorbiaceae: *Croton megalocarpa* Hutchison; *C. macrostachys* Delil; *C. dichogamus* Pax; *C. sylvaticum* Krauss.
- C. boueti* Feisthamel, and subspecies. Gramineae: *Arundinaria alpinus* K. Schaumann; *Oxytenanthera abyssinica* Munro.
- C. lasti* Smith. Caesalpinaceae: *Afzelia cuanzensis* Welwich; *Paramacrolobium coeruleum* (Taub) Leonard.
- C. protoclea* Feisthamel, and subspecies. Caesalpinaceae: *Afzelia cuanzensis* Welwich. Myrtaceae: *Syzygium guinensis* Willdenow; *S. caudatum* Krauss.
- C. lactetinctus* Karsch, and subspecies. Myrtaceae: *Syzygium cordatum* Krauss.
- C. eudoxus* Drury, and subspecies. Araliaceae: *Schefflera* spp. Myrtaceae: *Syzygium* spp.
- C. cynthia* Butler, and subspecies. Guttiferae: *Garcinia* sp. (unconfirmed; *Sevastopulo*).
- C. tiridates* Cramer, and subspecies. Sapindaceae: *Phialodiscus unijugatus* Baker. Linaceae: *Hugonia platysepala* Oliver (?); *H. castaneifolia* Engler. Ulmaceae: *Celtis africana* Burmeister; *C. durandi* Engler; *Chaetacme arisata* Planch (= *microcarpa*). Tiliaceae: *Grewia mollis* Jussieu; *G. tricarpa* Hochsteter (= *nyanzae* Drummond). Bombacaceae: *Bombax reflexum* Sprague. Flacourtiaceae: *Flacourtia indica* Merrill. Malvaceae: *Hibiscus* sp. undet.
- C. bipunctatus* Rothschild. Sapindaceae: *Phialodiscus unijugatus* Baker.
- C. numenes* Hewitson, and subspecies. Linaceae: *Hugonia platysepala* Oliver. Tiliaceae: *Grewia mollis* Jussieu; *G. forbesi* Masters. Papilionaceae: *Erythrina abyssinica* Lamarck; *E. excelsa* Baker. Sapindaceae: *Deinbollia fulvotomentella* Baker.
- C. bohemani* Felder. Caesalpinaceae: *Afzelia cuanzensis* Welwich.
- C. xiphares* Cramer, and subspecies. Laurinaceae: *Cryptocarya* spp.
- C. nandina* Rothschild. Euphorbiaceae: *Drypetes gerrardi* Hutchinson (= *battiscombei* Hutchinson). Papilionaceae: *Crabia brownei* Dunn (= *elliotti* Dunn).
- C. cithaeron* Felder, and subspecies. Sterculiaceae: *Cola laurifolia* Masters. Ulmaceae: *Chaetacme cristata* Planch (= *microcarpa*). Papilionaceae: *Crabia brownei* Dunn. Celastraceae (Hippocrataceae): *Hippocrates obtusifolia*. Caesalpinaceae: *Afzelia cuanzensis* Welwich.
- C. etheocles* Cramer, and subspecies. Rhamnaceae: *Scutia myrtina* Burmann. Ulmaceae: *Celtis durandi* Engler.
- C. viola* Baker, and subspecies. Mimosaceae: *Albizia coriaria* Oliver; *A. adianthifolia* Schoumacher (= *sassa*, *fastigiata*); *Entada abyssinica* Richmann; *E. gigas* Fawcett and Randle; *Acacia mellifera* Benth.
- C. cedreatis* Hewitson. Mimosaceae: *Albizia grandibracteata* Taub; *A. brownei* Oliver; *A. zygia* Macbride; *A. spp.*

- C. ethalion* Boissduval. Mimosaceae: *Parkia filicoidea* Oliver; *Piptadenia buchannani* Baker; *Tamarindus indicus* (exotic). Rhamnaceae: *Scutia myrtina* Burmann; *S. buxifolia*.
- C. virilis* Rothschild. Leguminosae: *Adenantha pavonina* (?).
- C. alpinus* van Someren, and subspecies. Mimosaceae: *Albizia gummifera* Smith. Rhamnaceae: *Scutia myrtina* Burmann.
- C. zingha* Stoll. Linaceae: *Hugonia castaneifolia* Engler; *H. platysepala* Oliver.
- C. eupale* Druce, and subspecies. Mimosaceae: *Albizia gummifera* Benth; *A. zygia* Macbride. Rhamnaceae: *Scutia myrtina* Burmeister.
- C. dilutus* Rothschild, and subspecies. Mimosaceae: *Albizia gummifera* (Benth) Smith.
- C. subornatus* Schauman, and subspecies. Mimosaceae: *Albizia brownei* Oliver; *A. gummifera* (Benth) Smith.
- C. zoolina* Westwood, and subspecies. Mimosaceae: *Acacia pennata* Willdenow; *Acacia* spp.
- C. varanes* Cramer, and subspecies. Sapindaceae: *Allophylus macrostachys* Gilger; *A. subcoriacius* Baker; *A. glaucescens*.
- C. fulvescens* Aurivillius, and subspecies. Sapindaceae: *Allophylus macrobothrys* Gilger.
- C. acuminatus* Thunberg, and subspecies. Sapindaceae: *Allophylus* spp. Melanthaceae: *Bersama abyssinicus* Fresenius.
- Palla ussheri* Baker, and subspecies. Convolvulaceae: *Bonamia poranoides* Hallier (= *Metaporana densiflora* Hallier).
- P. violinites* Crowley, and subspecies. Convolvulaceae: *Bonamia poranoides* Hallier (= *Metaporana densiflora* Hallier). Verbenaceae: *Clerodendron kentrocaule* Baker.
- Phalantha* (= *Atella*) *phalantha* Drury. Samydaceae: *Trimeria* spp. Celastraceae: *Gymnosporia* spp.
- P. columbina* Cramer. Flacourtiaceae: *Scolopia* spp.
- Lachnoptera iole* Fabricius. Flacourtiaceae: *Rawsonia lucida* Harvey and Sonder.
- L. ayersii* Trimen. Flacourtiaceae: *Rawsonia usambarensis* Schaumann.
- Catuna crithea* Drury. Melianthaceae: *Bersama abyssinicus* Fresenius.
- Pseudoneptis coenibita* Drury. Moraceae: *Antiaris toxicaria* Leschenault.
- Eurytela dryope* Cramer, and subspecies. Euphorbiaceae: *Ricinus communis* Linnaeus; *Tragia benthami* Pax (= *cordifolia*).
- E. hiabas* Drury, and subspecies. Euphorbiaceae: *Tragia benthami* Pax (= *cordifolia*); *Ricinus communis* Linnaeus.
- Issoria excelsior* Baker. Violaceae: *Viola abyssinica*.
- I. hanningtoni* Elwes. Violaceae: *Viola abyssinica*.
- Neptis seclava* Boissduval. Urticaceae: *Australina accuminata* Welw; *Acalypha paniculata*; *Quisqualis* sp.
- N. kariakofi* Overlaet. Sapindaceae: *Paullinia pinnata* Linnaeus. Urticaceae: *Pilea engleri* Randle; *Acalypha paniculata*.
- N. laeta* Overlaet. Mimosaceae: *Albizia zygia* Macbride.
- N. nemetes* Hewitson, and subspecies. Euphorbiaceae: *Alchornea cordifolia* Schaumacher.
- N. trigonophora* Butler, and subspecies. Sapindaceae: *Paullinia pinnata* Linnaeus.
- N. rogersi* Eltringham. Sapindaceae: *Paullinia pinnata* Linnaeus.
- N. strigata* Aurivillius. Verbenaceae: *Clerodendron capitatum* Schaumacher.
- N. poultoni* Eltringham. Verbenaceae: *Clerodendron* spp. Sapindaceae: *Paullinia* sp., near *pinnata* Linnaeus.
- N. melicerta* Drury. Euphorbiaceae: *Alchornea cordifolia* Schaumacher.
- N. nyssiades clareii* Neave. Sapindaceae: *Paullinia pinnata* Linnaeus.
- N. lativittata* Strand. Euphorbiaceae: *Cycina* sp. undet.

- Precis stygia* Aurivillius, and subspecies. Acanthaceae: *Paulowillhelmia sclerochiton* Lindau.
- P. tera elgiva* Drury. Acanthaceae: *Ruellia patulata* Jacquin.
- P. natalica* Felder. Acanthaceae: *Ruellia patulata* Jacquin; *Asystasia coromandeliana* (?).
- P. orithya madagascariensis* Guerin. Labiatae: *Englerastrum scandens* Alston; *Plectranthus* spp.
- P. limnoria* Klug. Acanthaceae: *Asystasia* spp.
- P. tugela* Trimen. Labiatae: *Englerastrum scandens* Alston.
- Vanessa cardui* Linnaeus. Urticaceae: *Urtica massaica* Milbred; *Obetia pennatifida* Baker; *Geriadina condensata* Wedd; *Laportia allipes* Hooker. Compositae: *Gnaphalium declinatum* Lesson (= *unionis*); *Heliochrysum* spp. Boraginaceae: *Cyanoglossum caeruleum* De Candolle; *C. lanceolatum* Forskel. Malvaceae: *Malva verticaliata* Linnaeus.
- Antanartia abyssinica* Felder. Urticaceae: *Urtica massaica* Milbred; *Obetia pennatifida* Baker.
- A. hippomene* Hubner, and subspecies. Urticaceae: *Australina acuminata* Weddenow; *Pouzolzia parasiticus* Schweinfurth.
- A. delius* Drury. Urticaceae: *Australina acuminata* Weddenow; *Pouzolzia parasiticus* Schweinfurth.
- A. schoenia* Trimen. Urticaceae: *Pouzolzia parasiticus* Schweinfurth.
- Aterica galene* Brown, and subspecies. Combretaceae: *Quisqualis littorea* (Engler) Exe. (Sevastopulo).
- Hypolimnas missipus* Linnaeus. Portulacaceae: *Portulaca quadrifida* Linnaeus; *Talium* sp.
- H. anthedon* Doubleday. Urticaceae: *Urtica hypselidendron* Weddenow.
- H. salmaceis* Drury. Urticaceae: *Urtica hypselidendron* Weddenow.
- H. monteironis* Druce. Urticaceae: *Urtica hypselidendron* Weddenow; *Urtica* spp.
- H. antevorta* Distant. Urticaceae: *Urtica* spp.
- H. usambarae* Westwood. Urticaceae: *Urtica hypselidendron* Weddenow.
- H. dubius* De Bauvais, and subspecies. Urticaceae: *Urtica hypselidendron* Weddenow.
- Asterope garega* Karsch. Euphorbiaceae: *Sapium mannicum* Benth.
- A. boisduvalii* Wallengren. Euphorbiaceae: *Sapium mannicum* Benth.
- A. occidentaliu* Moore. Euphorbiaceae: *Macaranga schweinfurthi* Pax.
- A. morantii* Trimen. Euphorbiaceae: *Macaranga kilimanjarica* Pax; *Excoecaria bussei* Pax.

ACRAEIDAE

- Bematistes quadricolor* Rogenhofer, and subspecies. Passifloraceae: *Adenia cissampeloides* (Planch) Harms; *Vitis* spp.
- B. anganice* Hewitson, and subspecies. Passifloraceae: *Tryphostemma zanzibaricum* Masters; *Adenia cissampeloides* (Planch) Harms.
- B. poggei* Doubleday, and subspecies. Passifloraceae: *Adenia* spp.
- B. tellus* Aurivillius, and subspecies. Passifloraceae: *Adenia* spp.
- Acraea johnstoni* Godman, and subspecies. Urticaceae: *Pouzolzia parasitica* (Forsk) Schweinfurth; cultivated New Zealand hemp (exotic).
- A. lycoa* Godart, and subspecies. Urticaceae: *Pouzolzia parasitica* (Forsk) Schweinfurth.
- A. esebria* Hewitson, and subspecies. Urticaceae: *Pouzolzia parasitica* (Forsk) Schweinfurth.
- A. rabbaei mombasa* Smith. Passifloraceae: *Tryphostemma zanzibaricum* Masters.
- A. zetes* Linnaeus, and subspecies. Passifloraceae: *Tryphostemma zanzibaricum* Masters; *Adenia cissampeloides* Harms; *Adenia lobata* (?).

- A. asboloplintha* Karsch, and subspecies. Passifloraceae: *Tryphostemma zanzibaricum* Masters; *Adenia lobata*.
- A. natalica* Boissduval, and subspecies. Passifloraceae: *Adenia cissampeloides* Harms; *Adenia lobata* (?).
- A. insignis* Distant. Passifloraceae: *Vitis* spp.
- A. quiralis* Smith. Urticaceae: *Urera hypselidendron* (Hochst) Weddenow.
- A. disjuncta* Smith. Urticaceae: *Urera hypselidendron* (Hochst) Weddenow.
- A. amacitiae* Heron, and subspecies. Urticaceae: *Urera hypselidendron* (Hochst) Weddenow.
- A. alcippoides* Le Daux. Urticaceae: *Urera hypselidendron* (Hochst) Weddenow.
- A. neobule* Doubleday. Passifloraceae: *Tryphostemma zanzibaricum* Masters.
- A. pharsalus* Ward, and subspecies. Moraceae: *Ficus exasperata* Vahl; *F. sycomorus* Linnaeus.
- A. quirina* Fabricius, and subspecies. Violaceae: *Rinorea poggei* Engler; *R. convallariflora* Brandt.
- A. cerasa* Hewitson. Flacourtiaceae: *Rawsonia lucida* Harvey and Sond; *R. usambarensis* K. Schauman. Violaceae: *Rinorea convallarifolia* Brandt.
- A. uvui* Smith, and subspecies. Tiliaceae: *Triumfetta rhomboidea* Jacquin; *T. macrophylla* Schaumann; *Sparrmannia ricinocarpa* O. Kuntz.
- A. bonasia* Fabricius, and subspecies. Tiliaceae: *Triumfetta macrophylla* Schaumann; *T. ruwenzorensis* Sprague.
- A. acerata* Hewitson. Convolvulaceae: *Ipomea batatas* Linnaeus.
- A. rangatana* Eltringham, and subspecies. Lythraceae: *Nesaea pediculata*; *Rotola* sp. undet. Rosaceae: *Alchemilla gracilipes* Engler.
- A. eponina* Cramer, and subspecies. Tiliaceae: *Triumfetta macrophylla* Schaumann; *T. rhomboides* Jacquin.
- A. rahira* Boissduval, and subspecies. Compositae: *Eregeron canadense* Linnaeus.
- A. aequatorialis* Neave, and subspecies. Passifloraceae: *Passiflora* sp. undet. Malvaceae: *Malva verticillata* Linnaeus.
- A. caecilia* Fabricius, and subspecies. Passifloraceae: *Adenia cissampeloides* (Planch) Harms.
- A. acrita* Hewitson, and subspecies. Passifloraceae: *Adenia* spp.
- A. doubledayi* Guerin. Passifloraceae: *Adenia* spp.
- A. sykesi* Sharpe. Passifloraceae: *Adenia* spp.
- A. calderina* Hewitson. Passifloraceae: *Adenia cissampeloides* (Planch) Harms.
- A. excelsior* Sharpe, and subspecies. Tiliaceae: *Triumfetta macrophylla* Schaumann.
- A. anacreon* Trimen. Rosaceae: *Alchemilla gracilipes* Engler.
- A. cabira* Hopffer. Tiliaceae: *Triumfetta* spp.
- A. oncaea* Hopffer. Ampelidaceae: *Vitis* spp. Passifloraceae: *Adenia* spp. Flacourtiaceae: *Oncoba routledgei* Sprague.
- Pardopsis punctatissima* Boissduval. Tiliaceae: Sp. indet. (Luganda name, "subi").

DANAIDAE

- Danaus chrysippus* Linnaeus. Asclepidaceae: *Gomphocarpus fruticosus* Linnaeus (= *phillipsae*); *G. physocarpa* Meyer; *G. semilunata* Richard; *G. kaesneri* Brown; *G. stenophyllus* Oliver (= *leuocarpa*); *Stathmostelma gigantiflorum* Schaumann; *S. pedunculatum* Decnesni (= *macrantha*); *Aspidoglossum interruptum* Bullock (= *Schizoglossum massaicum*); *Kanahia lasiflora* Forsk; *K. glaberrima*; *Cynanchum altoscadens* Schaumann; *C. abyssinicum* Dacnesni; *Pergularia extensa* (?); *Periploca linarifolia* (?); *Secamone platystigma* (= *africana* Oliver); *Caraluma* spp.
- Melinda formosa mercedonia* Karsch. Asclepidaceae: *Periploca linearifolia* (?); *Secamone platystigma* (= *africana* (Oliver) Bullock); *S. micranda* (?); *S.*

- punctulata* Decnesni; *S. zambesiaca* (= *parvifolia* (Oliver) Bullock); *Cryptolepsis* spp.
- Tirumala petiverana* Doubleday and Hewitson. Asclepidaceae: *Pergularia extensa* (= *Daemia extensa*).
- Amauris ansorgei* Sharpe, and subspecies. Asclepidaceae: *Tylophora stolzii* (?); *T. anomala* N. E. Brown; *Mardenia racemosa* (= *latifolia* Schaumann); *Cynanchum* spp.
- A. albimaculata* Baker. Asclepidaceae: *Tylophora anomala* N. E. Brown; *T. stolzii* (?); *Mardenia racemosa* (= *latifolia* Schaumann); *M. angolensis* N. E. Brown; *Cynanchum* spp.
- A. lobengula septentrionalis* Poulton. Asclepidaceae: *Tylophora stolzii* (?); *Mardenia racemosa* (= *latifolia* Schaumann); *M. angolensis* N. E. Brown; *Gymnema sylvestre* (Retz) Bullock.
- A. echeria* Stoll, and subspecies. Asclepidaceae: *Tylophora stolzii* (?); *mardenia racemosa* (= *latifolia* Schaumann); *Secamone africana* (Oliver) Bullock; *S. parvifolia* (Oliver) Bullock.
- A. niavius* Linnaeus, and subspecies. Asclepidaceae: *Gymnema sylvestre* (Retz) Bullock.
- A. ochlea* Boisduval, and subspecies. Asclepidaceae: *Tylophora stolzii* (?); *Cynanchum abyssinica* Decnesi.

SATYRIDAE

- Melanitis leda* Drury. Gramineae: *Setaria culcata*.
- Gnophodes grogani* Sharpe. Gramineae: broad-blade forest grasses.
- G. chelys* Fabricius. Gramineae: broad-blade forest grasses.
- G. parmeno* Doubleday. Gramineae: forest grasses.
- Bicyclus* (= *Mycalasis*) *safitza* Hewitson, and subspecies. Gramineae: grasses.
- B. iccius* Hewitson. Gramineae: grasses.
- Neocynura* spp. Gramineae: grasses.
- Henotesia* spp. Gramineae: grasses.
- Physenura* spp. Gramineae: grasses.
- Ypthima* spp. Gramineae: grasses.
- Aphyseura pigmentaria* Karsch, and subspecies. Gramineae: *Arundinaria alpinus* Schuman.

HESPERIIDAE

- Coeliades libeon* Druce. Euphorbiaceae: *Drypetes gerrardi* Hutchison (= *battiscombei* Hutchison).
- C. forestans* Cramer. Papilionaceae: *Indigofera* spp.; *Sesbania* spp.; *Crotolaria* spp. Asclepidaceae: *Mardenia senegalensis* (?); *M. schimperi* (Dacnesi) Bullock (= *Dregea schimperi*). Combretaceae: *Combretum panniculatum* Ventenat.
- C. pipistratus* Fabricius. Malpigiaceae: *Acridocarpus zanzibaricum* Jussien; *A. longifolium* (= *alopcurus* Sprague).
- C. keithloa* Wallengren, and subspecies. Malpigiaceae: *Acridocarpus zanzibaricum* Jussien; *A. glaucescens* Engler. Connaraceae: *Bryocarpus orientalis* (Baill) Baker.
- C. sejuncta* Mabilie. Malpigiaceae: *Acridocarpus zanzibaricum* Jussien.
- C. kenya* Evans. Malpigiaceae: *Acridocarpus* spp.
- C. anchises* Gerstecker. Asclepidaceae: *Mardenia angolensis* N. E. Brown.
- C. chalybe* Westwood. Asclepidaceae: sp. indet.
- C. hanno* Plotz. Malpigiaceae: *Acridocarpus* sp. indet.
- Artitropa erinnys* Trimen, and subspecies. Agavaceae: *Dracaena reflexa* Baker; *D. fragrans* Gawl.; *D. afromontana* Milbred; *D. nitens* Baker.
- A. comus* Cramer, and subspecies. Agavaceae: *Dracaena ugandae* (?); *D. manni* (?).

- A. milleri* Riley, and subspecies. Agavaceae: *Dracaena usambarensis* Engler.
Gamia bucholzii Plotz. Palmae: *Raphia mombutorum* (?); *R. farinifera* Hyland;
Borassus aethiopum Martin; *Phoenix reclinata* Jacquin.
G. shelleyi Sharpe. Palmae: *Raphia* spp.; *Borassus* spp.; *Phoenix* spp.
Zophotes cerymica Hewitson. Palmae: *Raphia* spp.; *Cocoa nucifer*.
Z. dysmephila Trimen. Palmae: *Raphia* spp.; *Borassus* spp.; *Phoenix* spp.
Zenonia zeno Trimen. Gramineae: cultivated maize and sorghums; grasses.
Pelopidas thrax Hubner. Gramineae: grasses.
P. fallax Gaede. Gramineae: grasses.
Lepella lepeletier Latreille. Gramineae: grasses.
Androdromus philander Hopffer. Sapindaceae: *Philodiscus zambesiacus* Radlk.
A. neander Plotz. Caesalpinaceae: *Brachystygia randii* (?); *B. spiciformis* Benthham.
Eretis djaelaelae Wallengren, and subspecies. Acanthaceae: *Asystasia schimperi* Anderson.
E. lugens Roggenhofer. Acanthaceae: *Asystasia schimperi* Anderson; *A. coromandeliana* (?); *Justicia leikepiensis* (?).
Eagris notoana Wallengren. Rhamnaceae: *Scutia myrtina* Kurz.
E. subadius Gray, and subspecies. Tiliaceae: *Grewia similia* Schultz; *G. forbesi* Masters.
E. leucetia Hewitson. Anacardiaceae: *Rhus vulgaris* Meikle; *R. villosa* Oliver.
Gomalia elma Trimen. Malvaceae: *Abutilon guinense* (Schumach) Baker; *A. holstii*.
Gorgyra bibulus Riley, and subspecies. Euphorbiaceae: *Drypetes gerrardi* Hutchison.
Spialia spio Linnaeus. Malvaceae: *Sida schimperiana* Hochsteter; *S. cordifolia* Linnaeus; *S. grewioides* (?); *S. cuneifolia* Roxburgh; *Hibiscus gossyphina* (?).
S. dromus Plotz. Sterculiaceae: *Waltheria americana* (?); *Malhamia* spp.
S. mafa Trimen. Malvaceae: *Sida cuneifolia* Roxburgh; *S. grewioides* (?); *S. rhombifolia* Linnaeus; *Hibiscus macrantha* (?).
S. zebra bifida Higgins. Sterculiaceae: *Melhamia ovata* Spreng; *M. velutina* Forskel.
S. kituina Karsch. Malvaceae: *Sida* spp.
S. confusa Higgins. Sterculiaceae: *Melhamia* spp.
S. diomus Hopffer. Tiliaceae: *Triumfetta macrophylla* Schuman.
Kedestes brunneistriga Plotz. Gramineae: *Setaria* spp.
Acleros mackenii Trimen. Sapindaceae: *Rhus coriarius*. Malpigiaceae: *Acridocarpus longifolius* (?).
Abantis paradisea Butler. Malvaceae: *Hibiscus* spp.
A. meru Evans. Compositae: *Vernonia jugalis* Oliver and Hierman.
Caprona canopus Trimen. Tiliaceae: *Grewia similis* K. Schaumann.
Gegenes hottentota Latreille. Gramineae: grasses.
G. letterstedti Wallengren. Gramineae: grasses.

PART 2. HOSTS AND NOTES ON EARLY STAGES, LYCAENIDAE

The following notes on the Lycaenidae are compiled from observations made jointly by the late T. H. E. Jackson and myself; unfortunately, they are very incomplete.

LIPTENINAE

- Teriomima subpunctata* Kirby, *micra* Smith. Lays eggs on lichens on bark of trees.
Baliocbila hildegarda Kirby, *dubiosa* Stempffer and Bennet, *fragilis* Stempffer and Bennet, *minima* Bowker Smith, *stygia* Talbot. Eggs laid among lichens on tree trunks.
Cnodontes vansomereni Stempffer and Bennet. Eggs laid on tree trunks among lichens.

- Telipna sanguinea* Plotz, *consanguinea* Rebel. Eggs laid on tree trunks among lichens. *Pentila amenida* Hewitson, *tachyroides* Dewitz, *nyasana clarensis* Neave. Seen resting on twigs and tall grass but egg laying not observed.
- Ornipholidotos muhata* Dewitz. Noted laying among lichen on twigs; larvae feed on lichens.
- Mimacraea poultoni* Neave, *marshalli dohertyi* Rothschild, and subspecies. Often noted resting on tree trunks, head downward. Eggs laid among lichens, on which larvae feed.
- Hewitsonia kirbyi intermedia* Joicey and Talbot. Lays eggs among small lichens on tree trunks, often close to ground.
- Epitola kamengoensis* Jackson, *cercene* Hewitson, *catuna carpenteri* Baker. Seen laying on twigs and tree trunks among lichens; eggs sometimes laid on dead bare twigs. Ants in attendance.
- Iridana incredibilis* Staudinger, *perdita marina* Talbot. Seen laying on lichen-covered branches. Larvae lie up in cracks in bark within a silken protective web.
- Deloneura (Ebepius) ochrascens littoralis* Talbot. Lays on tree trunks with small lichens; also seen laying eggs on slender bare twigs. Larvae usually in cracks in bark. Ants in attendance.
- Alaena caissa kagera* Talbot, *johanna* Sharpe, *ngonga* Jackson, *subrubra* Baker. Often seen resting on rock faces covered with lichens, but not actually seen laying; frequently noted resting on flowering heads of oat grass in vicinity of rock faces. Pupa found in crevices of rocks.
- Spalgis lemolea* Druce. Lays eggs on branches of small trees which are infested with coccids and scales. Larva feed on young coccids, and have been tried as a natural control of "mealey-bugs."

LYCAENINAE

- Lachnognema bibulus* Fabricius. Lays eggs on branches of small trees on which there are colonies of membracids and jassids. Larvae feed on the secretions of these, and also on immature membracids. Crematogaster ants also present but association not clear. Pupae found in ants' nests.
- Aslauga purpurascens* Holland, *lamborni* Baker. Eggs laid on twigs of a leafy branch where there is a collection of membracids. Larvae appear to prey on young membracids and coccids, lie up under portions of raised bark.
- Virachola* (= *Deudorix*) *dinocharis* Smith. Eggs laid on fruits of *Syzygium cardatum* Krauss (Myrtaceae). Larvae found within fruits, feeding on kernels; pupate within shell of fruit.
- V. antalus* Hopffer. Eggs laid on seed pods of Leguminosae, such as wild and cultivated peas and beans. The larvae feed on seeds within pods; have also been noted in seed pods of *Acacia stenocarpa* Hoschst. (Mimosaceae) and *Dolichos lablab* Linnaeus (Papilionaceae). Pupation occurs within empty pod or in cracks in bark in the case of *Acacia*.
- V. lorisona* Hewitson, *coffea* Jackson. Eggs laid on fruits of Rubiaceae, including cultivated coffee. Larvae bore into berries and eat seed sections within. Pupation occurs within empty shell.
- V. vansomereni* Stempffer. Eggs laid on, and larvae feed within, kernels of *Agalana obliqua* Scheilenb. (= *heterophylla* Gilman) (Connoraceae).
- V. dariaves* Hewitson. Eggs laid on, and larvae feed within, seed pods of *Brachystygia* spp. (Caesalpinaceae).
- V. suk* Stempffer. Lays eggs in or around galls of *Acacia* spp. (Mimosaceae) occupied by *Phidole* ants.
- V. dohertyi* Baker. Similar in habits to *suk*. Larvae often pupate within galls.

- V. jacksoni* Talbot. Although usually placed in the genus *Virachola*, this species lays eggs on leaves of *Loranthus usuiensis* (Loranthaceae), on which larvae feed.
- Aphnaeus* (*Paraphnaeus*) *hutchisoni* Trimen, and subspecies. Eggs laid on leaves of hostplant, but larvae always found within galls or swellings at point of implantation of parasitic *Loranthus*. These galls are found on *Acacia stenocarpa* Hochst., and *Entada abyssinicus* Stend. (Mimosaceae). Larvae appear to feed on woody substance of swellings and are associated with ants; but tunnels used by larvae, and in which they pupate, free of ants.
- A. orcas* Drury, and subspecies. Eggs laid on leaves of *Alchornea cordifolia* Schaumann and Thonning (Euphorbiaceae). Larva moves to edge of leaf where it feeds, curling edge over and attaching it with silken threads; rests within this tunnel, emerging to feed; tunnel enlarged as feeding progresses, and larva pupates within it.
- A. propinquus* Holland. Similar in habits to previous species, feeding on same foodplant, *Alchornea cordifolia* Schaumann and Thonning (Euphorbiaceae).
- Spindasis nyassae* Butler. Eggs laid on leaves of *Acacia stenocarpa* Hochst. and *Entada abyssinica* Steude (Mimosaceae). Larvae lie up in cracks in bark, emerging to feed on foliage, mainly at night; are ant attended.
- S. banyoana* Baker. Eggs laid on young shoots of *Acacia drepanolobium* Sjöstedt (Mimosaceae). Larvae collected by the ant *Phidole* and taken into galls, where they appear to feed on inner lining of gall and on secretions of ants; pupate within gall.
- S. tavetensis* Lathy. Eggs laid on young shoots of *Acacia drepanolobium* Sjöstedt (Mimosaceae). Larvae subsequently located on or within galls, attended by *Phidole* ants.
- S. victoriae* Butler. Eggs laid on young shoots of *Acacia* sp. indet. (Mimosaceae). Larvae are subsequently located within massed dead leaves held together with silken threads; pupate within this mass.
- S. homeyeri fracta* Stempffer. Similar in habits to above species.
- S. appeles nairobiensis* Sharpe. Seen laying on leaves of *Rhus villosa* Oliver (= *vulgaris* Meikle) (Anacardiaceae), but larvae and pupae were not located.
- Chloroselas pseudozeritis tytleri* Riley. Eggs laid on young shoots of *Acacia stenocarpa* Hochst. (Mimosaceae). Young larvae detected in massed leaflets and twigs, but later found in cracks in bark, where they subsequently pupate. Crematogaster ants in attendance.
- Axiocerses amanga* Westwood, and subspecies. Eggs laid on leaves of *Ximenia americanum* Linnaeus (Oleaceae). Larvae feed on leaves toward the edge, bringing edge of leaf over to form a tunnel, held down by silken threads; emerge to feed on adjacent leaves at night, returning to tunnel by day. Pupate within these "hides." Attended by ants of the genus *Componotus*.
- A. harpax perion* Cramer. Eggs laid on leaflets of *Acacia drepanolobium* Sjöstedt (Mimosaceae). Larvae and pupae found within galls, attended by *Phidole* ants.
- A. (harpax) tjoene* Wallengren. Seen laying on leaflets of *Brachystygia spiciformis* Benthams (Caesalpinaceae), but larvae not located.
- Leptomyrina lara* Linnaeus. Eggs laid on leaves and stems of *Kalanchoe lugardi* Bullock (Crassulaceae). Larvae eat into leaves, feeding on soft body between upper and lower cortex; emerge to pupate on main stem of plant or at base of leaf stalk.
- Myrina silenus* Fabricius. Eggs laid on young shoots of various figs (*Ficus ingens* Miquel, *F. hochstetteri* Reichmann; Moraceae). Larvae move onto more mature leaves, and pupate on stem at base of a leaf. Highly cryptic.
- M. silenus ficedula* Trimen. Eggs laid on various figs, including those listed above. After feeding on mature leaves, larvae pupate on stem, being attached by the flattened "tail end," thus simulating a small fig fruit.

- M. dermaptera dermaptera* Wallengren, *d. nyasae* Talbot. Lays on various species of Moraceae, showing a preference for *Ficus thonningii* Blume. Habits as with other *Myrina*.
- M. sharpei* Baker. Noted laying on *Ficus capensis* Thunberg (Moraceae), but mature larvae not found.
- Hypolycaena phillipus* Fabricius. Eggs laid on shoots of *Ximena americana* Linnaeus (Oleaceae). Larvae found on or in seed capsules, for which they forage. *Clerodendron capense* Thunberg (Verbenaceae) is also utilized. Once seen laying on *Loranthus dredgei* (Loranthaceae).
- H. pachelei* Butler. Noted laying on *Combretum constrictum* Lawson (Combretaceae), but other stages not found.
- Stugeta (Iolaus) bowkeri* Trimen, and subspecies. Eggs laid on *Ximena americana* Linnaeus (Oleaceae) and *Loranthus dredgei* (Loranthaceae). Larvae on *Loranthus* feed on leaves, and pupate on stem.
- S. marmorea olalae* Stoneham. Eggs laid on, and larvae feed on, leaves of *Ximena americana* Linnaeus (Oleaceae), but all stages not located.
- S. carpenteri* Stempffer. Noted laying on leaves and flowers of *Loranthus fischeri* Engler (Loranthaceae). Imagoes can be beaten out of *Loranthus* clumps, but larvae and pupae not located.
- S. mimetica* Aurivillius. Eggs laid on *Loranthus* sp. indet.
- Argiolaus (Iolaus) crawshayi* Butler, and subspecies. Eggs laid on younger leaves of parasitic *Loranthus usuiensis* Oliver and *L. dredgei* (Loranthaceae). Larvae feed on leaves and flowers, pupating on stem towards base of a leaf and attached by posterior end to a silken pad spun on surface. Pupa very cryptic.
- A. silas silarus* Druce. Similar in habits to previous species and associated with same species of *Loranthus*.
- Philolaus parasilanus* Rebel, and subspecies. Associated with parasitic *Loranthus* sp. indet. (Loranthaceae).
- Iolaphilus ituriensis* Joicey and Talbot. Lays on *Loranthus* sp. indet. (Loranthaceae).
- Epamera (Iolaus) basana yalae* Riley. Noted laying eggs on leaves and flowers of *Loranthus woodfordoides* Schweinfurth and *L. fischeri* (Engler) Balle (Loranthaceae). Larvae feed largely on flowers, but eat leaves also. Pupate on stems of parasite or on nearby host tree.
- E. iasis albomaculatus* Sharpe. Seen laying on *Loranthus* sp. indet.
- E. arborifera* Butler. Lays on *Loranthus freisiorum* and *L. woodfordoides* Schweinfurth (Loranthaceae).
- E. tajorica* Walker. Eggs laid on *Loranthus (Odontella) fischeri* (Engler) Balle (Loranthaceae).
- E. mimosae haemus* Talbot. Eggs laid on *Loranthus fischeri* (Engler) Balle and *L. recurviflora* (Loranthaceae).
- Iolaus (Pseudiolaus) poultoni* Riley. Seen laying on leaves and flowers of *Loranthus recurviflora*, on which larvae feed.
- Iolaus (Aphniolaus) pallene* Wallengren. Eggs laid on *Loranthus fischeri* (Engler) Balle and *L. woodfordoides* Schweinfurth (Loranthaceae), as well as *Ximena americana* Linnaeus (Oleaceae).
- Anthene hodsoni hodsoni* Talbot, *h. usamba* Talbot. Eggs laid on young shoots of *Acacia drepanolobium* Sjoestedt (Mimosaceae). Young larvae found in galls, probably taken there by attending *Phidole* ants.
- A. amarah* Guerin. Eggs laid on *Acacia sieberiana* De Candolle (= *purpurascens* Vatke), as well as *A. abyssinica* Hochsteter and *A. stenocarpa* Hochsteter (Mimosaceae). Larvae pupate on the stems or leaves; pupa very cryptic. Larvae attended by *Crematogaster* ants.
- A. definita* Butler. Common widespread species noted laying eggs on several food-plants of different families, including *Acacia sayal* Delil, *A. stenocarpa* Hoch-

- steter, *A. abyssinica* Hochsteter, *Albizia* spp. (Mimosaceae); *Bersama engleriana* Gurke, *B. abyssinica* Fresenius (Melanthaceae); *Kalanchoe lugardii* Bullock (Crassulaceae); and *Rhus incana* Millerm (Anacardiaceae).
- A. *larydas* Cramer. Eggs laid on, and larvae feed on, leaves of *Albizia gummifera* C. A. Smith, *A. zygia* Macbride, *Acacia farnesiana* Wild., and *Dichrostachys glomerata* Hutchison (Mimosaceae).
- A. *princeps* Baker, *ugandae* Butler. Eggs laid on, and larvae feed on, leaves of *Entada abyssinicus* Richard (Mimosaceae). Pupae found on leaves and stems.
- A. *livida* Trimen. Eggs laid on succulent leaves and flowers of *Kalanchoe crenata* Hewitson and *K. lateralis* (Crassulaceae). Larvae feed on flowers by preference, but also on young seeds and leaves; pupate on leaves or stems.
- A. *lunulata* Baker. Eggs laid on, and larvae feed on, young shoots of *Entada abyssinica* Richard (Mimosaceae). Also noted laying on *Combretum* spp. (Combretaceae).
- A. *indefinita* Baker. Eggs laid on young shoots of *Erythrococca rigidifolia* Pax (= *bongensis* Pax). Larvae move to more mature leaves and eventually pupate on a leaf or under cluster of dead flowers.
- A. *crawshayi* Butler. Foodplant is *Entada abyssinica* Richard. Eggs laid on tender leaves, on which larvae commence to feed, later moving to more mature leaves. Pupate on leaves or stems on bark. Adults also lay on *Acacia abyssinica* Hochsteter (also Mimosaceae).
- A. *nigeriae* Aurivillius. Lays on young leaf shoots of *Acacia stenocarpa* Hochsteter (Mimosaceae). Larvae attended by Crematogaster ants.
- A. *pitmani* Stempffer. Eggs laid on young shoots of *Acacia stenocarpa* Hochsteter, as well as on *A. abyssinica* Hochsteter and occasionally on young plants of *A. lahai* Stendel (Mimosaceae). Newly hatched larvae feed on young foliage, then move onto more mature leaves. Crematogaster ants in attendance.
- A. *otacilla kikuyu* Baker. Seen laying on young shoots of *Acacia stenocarpa* Hochsteter and *A. lahai* Stendel (Mimosaceae). As young larva grows, moves from young leaves to mature ones. Pupa found on stems or in cracks in bark. Attended by Crematogaster ants.
- Uranothauma falkensteini* Dewitz. Eggs laid on young leaf shoots of *Albizia adianthifolia* Schauman (= *fatgiata* and *sassa* auct.) and *Acacia abyssinica* Hochsteter (Mimosaceae). Larvae feed on young leaves, then move to mature ones, on which they may pupate, although usually on stem.
- U. *delatorum* Heron. Lays on young leaves of *Albizia gummifera* Smith, but larvae soon move onto more mature leaves and may pupate either on old leaves or on main stem of branch.
- U. *nubifer* Trimen. Prefers laying on *Albizia gummifera* Smith and *A. coriaria* Oliver, but may also lay on *Acacia abyssinica* Hochsteter (Mimosaceae).
- Phylaria cyara* Hewitson, and subspecies. Lays on tender leaf shoots of *Albizia gummifera* Smith (Mimosaceae). Larvae move onto mature leaves and either pupate on them or on main branch of leaf spray.
- P. *heritsia* Hewitson. Eggs laid on young leaves of *Bridlea macrantha* Baillon (Euphorbiaceae), preferring the foliage of saplings.
- Castalius calice* Hopffer. Eggs laid on young leaf shoots of *Zizyphus jujubae* Linnaeus (= *mauritiana* Lamarck) (Rhamnaceae).
- C. *margaritacea* Sharpe, and subspecies. Seen laying on leaves of *Gouinia longispicata* Engler. Pupates towards base of mature leaves.
- C. *cretosa* Butler. Foodplant is *Zizyphus jujubae* Linnaeus (Rhamnaceae). Larvae first eat young leaves, then move to mature ones, eating cuticle only. Pupate on underside of old leaves or on leaf stalks.
- C. *hintza* Trimen. Lays on younger leaves of *Zizyphus jujubae* Linnaeus (= *mauri-*

- taniana* Lamarck) (Rhamnaceae). As larvae mature, move onto older leaves, but eat only outer cortex. Pupate on underside of old leaves.
- Turacus mediteraneus* Baker. Eggs laid on younger leaves of *Zizyphus jujubae* Linnaeus (= *mauritaniana* Lamarck) (Rhamnaceae). Larvae move from these to older leaves. Pupate among leaves or on stems.
- T. ungemachi* Stempffer, *grammicus* Smith. Both species have habits similar to previous ones. Also lay eggs on *Zizyphus abyssinica* A. Richard.
- Azanus mirza* Plotz. Noted laying on *Allophylus alnifolius* Radlikofer (Sapindaceae) and *Dichrostachys glomerata* Hutchison (Mimosaceae).
- A. natalensis* Trimen. Eggs laid on young shoots of *Acacia abyssinica* Hochsteter (Mimosaceae). Larvae ant-attended.
- A. jeseus* Guerin. Eggs laid on young shoots of *Acacia stenocarpa* Hochsteter and *A. abyssinica* Hochsteter (Mimosaceae). Larvae move to older foliage and pupate on stem of branch.
- A. isis* Drury. Foodplant is *Dichrostachys glomerata* Hutchison. Eggs laid on young leaf shoots on which young larvae feed, later moving to mature foliage; eventually pupating on stem of branch.
- Syntarucus telicanus* Lang. Wide range of foodplants, mostly Papilionaceae: *Crotolaria agatifolia* Schweinfurth; *Sesbania aegyptiaca* Person; *S. sesban* Linnaeus; *Indigophora tinctoria*; *I. erecta* Hochsteter; also wild and cultivated peas and beans. Also feeds on *Plumbago* spp. (Plumbagataceae). Eggs usually laid on or near flowers and younger shoots. Larvae burrow into seed pods to eat seeds; often pupate within pods.
- Lampides baeticus* Linnaeus. Lays on several species of *Crotolaria* (Papilionaceae); oviposition on or near flowers. Larva burrows into seed pod, where it destroys seeds. Often noted on cultivated peas.
- Caclirius crawshayimus* Aurivillius. Lays eggs on main stem of *Cyanoglossum lanceolatum* and *C. coeruleum*, both wild and cultivated (Boraginaceae). Eggs deposited just above ground level. Larva eats outer cortex of root, then works up stem, where it pupates. Imago can only emerge when stem breaks on withering.
- Cacyreus lingeus* Cramer. Labiates seem the foodplants of preference; among the many are *Coleus lactiflorus* Vatk.; *C. forskelli* Wild.; *Calamintha simensis* Bentham; *C. elgonensis* Bullock (Labiatae). Eggs laid on flowers and young seed pods.
- Euchrysops malathana* Boisduval. Eggs laid in flowering heads of *Vigna monophylla* Taubert, and other species (Papilionaceae). Larvae eat flowers and young developing pods.
- E. osiris* Hopffer, *dolorosa* Trimen. Both are similar in habits to *malathana*, utilizing same foodplants, mainly *Vigna monophylla* Taubert.
- Cupidopsis cissus* Godart. Foodplant of preference seems to be *Eriosema cordifolia* Hochsteter (Papilionaceae). Eggs laid on flowering heads, and larvae burrow into pods, eating the seeds.
- Eicochrysops mahalakoena* Wallengren. Noted laying eggs on flowers of *Acacia saval* Delil (Mimosaceae).
- Chiliades kedonga* Smith. Noted laying eggs on young shoots and flowers of *Acacia* spp. (Mimosaceae).
- Zizula hylas* Fabricius, *gaika* Trimen. Both species lay eggs on flowers of *Oxalis corniculata* Linnaeus (Oxalidaceae). Larvae enter seed heads.
- Actizera lucida* Baker, *stellata* Trimen. These seen laying eggs on flower heads of *Oxalis corniculata* Linnaeus (Oxalidaceae) and *Vigna* spp. (Papilionaceae).
- Lepidochrysops* spp. Noted that many species of this genus lay eggs on small Labiatae in vicinity of "harvester" ants and allied species. Young larvae collected by ants and taken to nest where tended, feeding on fungi (?). Imagoes emerge from ants' nests after onset of the rains.

Lycaena abboti Holland, *phlaeus aethiopica* Poulton, *pseudophlaeus* Lucas. These three species lay eggs on species of *Rumex*, in particular *nipalensis* (= *bequartii* Wild.) and *abyssinicus* (Polygonaceae). Eggs laid on flowering heads and seeds, on which young larvae feed, before moving to leaves.

Alocides conradsi Aurivillius, *ochrascens* Joicey and Talbot. Females seen laying eggs in trails of ants. When larvae hatch, collected and taken by ants to nest. What they feed on not known.

Capys catharus Riley. Lays eggs on flowers of *Protea*. Larvae penetrate to base of flower head, and feed and pupate in this area.

BUTTERFLIES TAKEN IN LIGHT TRAPS

During 1973 three light traps were operated at Edgard, St. John the Baptist Parish, Louisiana. During this period 607 butterflies, representing 28 species, were taken in the traps. The distribution of individuals by species in order of abundance was as follows:

<i>Asterocampa celtis celtis</i>		<i>Panoquina ocola</i> (Edwards)	6
(Boisduval & Le Conte)	191	<i>Eurema lisa</i> Boisduval & Le Conte	5
<i>Libytheana bachmanii bachmanii</i>		<i>Precis coenia</i> (Hübner)	5
(Kirtland)	167	<i>Euptoieta claudia</i> (Cramer)	4
<i>Asterocampa clyton clyton</i>		<i>Limenitis arthemis astyanax</i>	
(Boisduval & Le Conte)	98	(Fabricius)	4
<i>Euptychia hermes sosybia</i>		<i>Panthiades m-album</i>	
(Fabricius)	17	(Boisduval & Le Conte)	3
<i>Satyrium calanus falacer</i>		<i>Epargyreus clarus clarus</i> (Cramer)	3
(Godart)	15	<i>Pyrgus communis communis</i>	
<i>Calycopis cercrops</i> (Fabricius)*	13	(Grote)	3
<i>Polites vibex vibex</i> (Geyer)	12	<i>Colias eurytheme eurytheme</i>	
<i>Polygonia interrogationis</i>		Boisduval	2
(Fabricius)	12	<i>Phyciodes tharos tharos</i> (Drury)	2
<i>Phyciodes phaon</i> (Edwards)	10	<i>Vanessa atalanta rubria</i>	
<i>Strymon melinus melinus</i> Hübner	8	(Fruhstorfer)	2
<i>Limenitis archippus watsoni</i>		<i>Phoebis sennae eubule</i> (Linnaeus)	1
(dos Passos)	7	<i>Cynthia virginiensis</i> (Drury)	1
<i>Hylephila phyleus</i> (Drury)	7	<i>Polites themistocles</i> (Latreille)	1
<i>Lerema accius</i> (Smith)	7	<i>Atalopedes campestris</i> (Boisduval)	1

* Subsequent to the compilation of these data, Mr. Harry K. Clench called to the attention of Bryant Mather the possibility that some material from this region, previously determined as *C. cercrops* (Fabricius) might be properly assignable to *C. isobeon* (Butler & Druce).

Data on occurrence and distribution of butterflies in Louisiana have been compiled by Lambremont (1954, Tulane Stud. Zool. 1: 125-164), Ross & Lambremont (1963, J. Lepid. Soc. 17: 148-158), Lambremont & Ross (1965, J. Lepid. Soc. 19: 47-52), Mather (1966, J. Lepid. Soc. 20: 102), and Strickland (in prep.). From a review of these data it appears that all of these species, except *P. coenia*, have not heretofore been recorded from St. John the Baptist Parish. Two were not known to occur in Louisiana at the time of Lambremont's 1954 work or Ross & Lambremont's of 1963, but were added to the Louisiana list in 1965 by Lambremont & Ross. These are *S. calanus falacer* (Godart) (reported as *C. c. calanus* (Hübner)) and *Panthiades m-album* (B & L) from East Baton Rouge and West Feliciana Parishes only, respectively.

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ENTOMOLOGICAL BIBLIOGRAPHY OF KENNETH JOHN HAYWARD (1891-1972)

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The following list of publications was compiled from a list in the library of the British Museum (N.H.). The original list was based upon Hayward's own records and brought together by Miss N. Schechaj of the Instituto Miguel Lillo, Tucumán, Argentina. I have omitted several non-entomological articles. Three articles were in press at the time the original list was compiled for transmission to the British Museum (N.H.) in November 1972. In many cases, Hayward did not give complete references to his articles. Where possible I have supplied the missing data. In others, such as the first two, I have not been able to locate copies of the journal involved.

1. A note on *Mantis religiosa*. Egyptian Gazette (1920).
2. Cyprus, a holiday resort for entomologists. Egyptian Gazette (1921).
3. *Aporia crataegi* L. in Cyprus. Entomol. 54: 212 (1921).
4. *Coenonympha pamphilus*, var. Entomol. 54: 290 (1921).
5. Some curious aberrations of *Danais chrysippus* L. Entomol. 55: 178-179 (1922). [ab. *axantha*, p. 178; ab. *candidata*, p. 179, both Egypt]
6. *Danais chrysippus* L. ab. *candidata* Hayw. Entomol. 55: 212 (1922).
7. Hybridization in nature. Entomol. 56: 43 (1923).
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UNUSUAL COPULATORY BEHAVIOR IN *EUPHYDRYAS CHALCEDONA* (DOUBLEDAY) (NYMPHALIDAE)

A very unusual copulation between two males and one female of *Euphydryas chalcedona* was observed on 13 June 1974 in Whitewater Canyon, San Bernardino Mountains, Riverside County, California. The three individuals were disturbed from a mating position at the top of a bush. Flight was attempted by the female who carried the two males with her. She was barely able to fly with this weight and the flight was on a downward trajectory until intercepted by my net. The three butterflies were genitally attached and appeared to be in copula. They remained so in the net and after being dispatched by pinching. All three individuals were very fresh, especially the female who had one hind wing incompletely opened. It is possible that this mating occurred before the female had flown. The time of day was 1300 PDT.

A similar mating between two males and one female of *Phyciodes phaon* was reported by Perkins (1974, J. Lepid. Soc. 27: 291-294) who referred to it as a pleoheterosexual coupling. As far as I can ascertain, no other examples of a copulation between three or more individuals of Lepidoptera have been reported in the literature.

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ECOLOGICAL STUDIES OF RHOPALOCERA IN A SIERRA
NEVADAN COMMUNITY—DONNER PASS, CALIFORNIA.
V. FAUNAL ADDITIONS AND FOODPLANT
RECORDS SINCE 1962

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Ten years have passed since the publication of the last of a series of four papers (Emmel & Emmel, 1962a, 1962b, 1963a, 1963b) on the butterfly associations and distributional factors affecting some 74 species of Rhopalocera in a montane ecosystem of the Sierra Nevada in California. With further study since our initially reported observations, a number of additional butterfly species have been recorded for this Donner Pass region and subsequent intensive investigations of hostplant relationships have been carried out by the authors and other California workers. A total of 83 butterfly species are now known for this four-square-mile area, making it the richest montane fauna of any reported temperate-zone area of comparable size (Emmel & Emmel, 1963b, p. 99).

In the following report, species for which new hostplant information is known are listed by family name and the species number previously used in Emmel & Emmel (1962a). Some of the host identifications made in 1956 and 1960 in the Donner Pass region have been changed from the original botanical names given to the the authors, and listed in Emmel & Emmel (1962a), due to subsequent submission of voucher material to other botanical specialists. The butterfly species new to the previously-recorded fauna are also listed (with an asterisk) at the end of each family section, with numbers subsequent to those for species recorded originally for the family.

A. PAPILIONIDAE

1. *Papilio zelicaon zelicaon* Lucas. Previously recorded on "*Cymopterus terebinthinus*," this foodplant is now known as *Pteryxia terebinthina* (Hook.) C. & R. var. *californica* Math.
2. *Papilio indra indra* Reakirt. The change in host identification is identical to that for *P. zelicaon*.
4. *Papilio eurymedon* Lucas. The foodplant in this locality is now strongly suspected to be *Ceanothus cordulatus* Kell., from observations of females hovering around this particular species.
5. *Parnassius clodius baldur* Edwards. Females have been observed ovipositing

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on or near *Sedum obtusatum* Gray (Emmel & Emmel, 1962a); however, this *Sedum* is only one of several oviposition substrates and is not a foodplant, as the normal host for the larvae appears to be *Dicentra uniflora* Kell. (Fumariaceae) (J. F. Emmel, unpubl.), which is abundant right after snow melt on the slopes where *baldur* flies later in the summer (when the *Dicentra* plants are dried and shriveled, e.g. on 18 July 1970).

B. PIERIDAE

3. *Pieris occidentalis* Reakirt. All of our material previously called *P. protodice* is now referable to *P. occidentalis*, a sibling species as defined by Chang (1963).

5. *Euchloe hyantis hyantis* Edwards. The foodplant on the lower slopes of Mt. Judah is *Streptanthus tortuosus* Kell. var. *orbiculatus* (Greene) Hall (Cruciferae). Several females were observed (18 July 1969) to oviposit on the buds of this mustard.

6. *Anthocharis sara stella* Edwards. Name changed from *A. s. julia* Edwards. Two local food plants for this butterfly are *Arabis platysperma* Gray (females ovipositing 21 June 1970, and ova plus larvae found on 11 July 1971) and *Arabis lyallii* Wats. (ova on 21 June 1970).

*10. *Pieris protodice* Boisduval & LeConte. Shapiro (1974) took this species from 27 June to 28 September 1973 in the Donner Pass area.

*11. *Pieris beckerii* Edward. This species was recorded by Shapiro (1974) from 25 July to 24 August 1973 in the Donner Pass area.

D. SATYRIDAE

2. *Cercyonis oetus oetus* (Boisduval). Name change from *C. sthenele oetus* (see Emmel, 1969).

*3. *Oeneis ivallda* (Mead). The presence of this species was first called to our attention by Noel La Due (in litt., 7 August 1963). He found it on the north slope of Mt. Judah on 16 July 1963 in fair numbers. One of us (JFE) in company with Oakley Shields took *ivallda* on 15 June 1969, 18 July 1969 and 11 July 1971. (The same areas had been checked in 1970, with no adults seen.) Our previous Donner Pass collections were made in 1956 and 1960. Thus the *Oeneis ivallda* populations in the Donner Pass region seem to be synchronized to fly only in odd-numbered years (a two-year cycle is well known for *Oeneis nevadensis* Felder & Felder and *O. jutta reducta* McDunnough in California and Colorado). The suspected foodplant is *Carex spectabilis* Dewey, with which females have been observed to be closely associated. This locality, at 7200 ft. elevation, is the lowest altitudinal record known for *Oeneis ivallda*.

E. NYMPHALIDAE

9. *Phyciodes campestris montana* Behr. An egg mass of 118 eggs was found on the underside of a leaf of *Aster occidentalis* (Nutt.) T. & G. in a wet meadow near Lake Mary on 21 August 1971. This *Aster* species is probably the same species we referred to (Emmel & Emmel, 1962a) as *Aster integrifolius* Nutt.

11. *Polygonia zephyrus* Edwards. Correct name for foodplant is *Ribes cereum* Dougl. rather than *R. viscosissimum* Pursh.

18. *Cynthia annabella* Field. Name change from *Vanessa carye* Hübner. Host-plant here is *Sidalcea glaucescens* Greene (Malvaceae).

*21. *Speyeria egleis egleis* (Behr). This species is about as abundant as the phenotypically very similar *Speyeria mormonia arge* (Strecker) throughout the Pass area. Observations during July 1969 showed that *S. egleis* prefers dry meadows and montane slopes while *S. mormonia* prefers forest edges.

*22. *Adelpha bredowii californica* (Butler). On 21 June 1970, three females

were collected on the slope between Donner Pass and Mt. Judah at elevations between 7200 and 7500 feet (perhaps a new altitude record for this subspecies). One of these females was observed to oviposit on a leaf tip of *Quercus vaccinifolia* Kell. *Adelpha* has not been observed previously in the Pass region, and this 1970 record may represent merely an occasional high-altitude invasion by a predominantly low-land species.

F. LYCAENIDAE

3. *Satyrrium saepium* (Boisduval). This hairstreak feeds on a small-leaved *Ceanothus* (unidentified), previously erroneously identified for us as *C. velutinus* Dougl. ex Hook.

4. *Satyrrium behrii* (Edwards). The foodplant in the Donner Pass area is *Purshia tridentata* (Pursh) D.C., which grows on the ridge and upper slopes of Mt. Judah.

5. *Satyrrium fuliginosum* (Edwards). On 15 June 1969, seven mature larvae were collected in debris and soil at the base of plants of *Lupinus arbustus* Douglas on the summit of Mt. Judah.

8. *Mitoura nelsoni nelsoni* (Boisduval). On 18 July 1970, a worn male was taken in association with *Juniperus occidentalis* Hook. on the north slope of Mt. Judah (at lower elevations this butterfly is commonly associated with *Calocedrus decurrens* Torr., which is absent from Donner Pass). We suspect this *Juniperus* to be the food plant of *M. nelsoni* at Donner Pass.

11. *Callophrys lemberti* Tilden. Name change from *C. dumetorum perplexa* Barnes & Benjamin. Suspected foodplant is *Eriogonum marifolium* Torrey & Gray, with which the adults are very closely associated on the slopes of Mt. Judah.

12. *Lycaena arota virginienensis* Edwards. The previously misidentified host species is actually *Ribes roezlii* Regel, not *R. montigenum* McClat.

13. *Lycaena editha* Mead. Two females were observed to oviposit in ground litter near *Rumex acetosella* L., near Lake Mary on 21 August 1971. This introduced dock is common throughout the Donner Pass meadows.

14. *Lycaena nivalis* Boisduval. The foodplant is *Polygonum douglasii* Greene in other Pacific montane areas (Newcomer 1911, 1964); since this plant grows in the Donner Pass area, it is very probably the foodplant here.

15. *Lycaena cupreus* (Edwards). The host plant is *Rumex acetosella* L. in the Lodge Meadow and Lake Mary areas. Previous recordings of unreared larvae on *Calyptridium* are almost certainly not this copper, but more probably larvae of *Strymon melinus* Hübner.

18. *Lycaeides argyrognomon anna* (Edwards). On 18 July 1969 a female was observed to oviposit on a *Lupinus* species on the north slope of Mt. Judah; the plant lacked flowers or fruit and could not be identified as to species.

2. *Plebejus shasta* (Edwards). On 15 June 1969 six mature larvae were found on flowers of and at the bases of plants of *Astragalus whitneyi* Gray on the north slope of Mt. Judah.

23. *Plebejus lupini* Boisduval. Goodpasture (1973) has raised this taxon to specific level (name change from that used in Emmel & Emmel (1962a)). Adults are closely associated with *Eriogonum umbellatum* Torrey, the suspected foodplant at Donner Pass.

24. *Agriades glandon podarce* Felder & Felder. The foodplant at Donner Pass is apparently *Dodecatheon* species (Primulaceae), based on close association of adults with these plants.

25. *Glaucopsyche lygdamus columbia* Skinner. Name change from *G. l. behrii* (Edwards) (after Langston, 1969).

27. *Philotes battoides intermedia* Barnes & McDunnough. The adults are closely associated with *Eriogonum umbellatum* Torrey, the probable foodplant.

*29. *Incisalia fotis windi* Clench. On 10 July 1971 three first-instar and six fourth-instar larvae were found feeding on flowers and leaves of *Sedum obtusatum* Gray near Lake Mary. No adults had been previously recorded for the area.

*30. *Lycaena mariposa* Reakirt. On 17 July 1963 Noel La Due took three adults on a north-facing slope near Lake Mary.

*31. *Apodemia mormo* (Felder & Felder). On 17 August 1973, Shapiro took this species at Donner Pass. Details on its habitat will be published by him in a future paper. We had previously noted its suspected Sierran foodplant, *Eriogonum wrightii* Torr. ex Benth., to be abundant on the granite rock slopes at Donner Pass.

G. HESPERIIDAE

1. *Thorybes nevada* Scudder. This skipper is closely associated with a *Trifolium* (Leguminosae) species, the suspected foodplant.

4. *Erynnis propertius* (Scudder & Burgess). Determination change from *E. juvenalis* (Fabricius) (C. D. MacNeill, in litt.). The foodplant at Donner Pass is strongly suspected to be *Quercus vaccinifolia* Kell.

5. *Erynnis persius* (Scudder) complex. Determination change from *E. afranius* (Lintner) (Burns 1964).

*11. *Ochlodes sylvanoides* (Boisduval). Shapiro has taken this species in the Donner Pass region (17 August–5 October 1973) and will publish detailed data on its ecological associations in a future paper.

H. POSSIBLE FUTURE ADDITIONS TO THE BUTTERFLY FAUNA OF DONNER PASS

1. *Parnassius phoebus behrii* Edwards. Specimens of this species were seen on Mt. Anderson and Tinker Knob in 1960, south of the Donner Pass area; the ridge connecting these peaks also extends to Mt. Lincoln, just inside the study area delineated in our 1962a paper. Because Mt. Lincoln is similar in habitat and flora to these peaks south of it, it is probable that this *Parnassius* will be eventually be taken there, also.

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ONE NEW SPECIES AND TWO RANGE EXTENSIONS FOR BRITISH COLUMBIA BUTTERFLIES

During the summer of 1972 the second author was collecting butterflies in northern British Columbia. Among the many extensions of butterfly distribution noted, three were of uncommon interest. These were all collected at one locality and in one day: Mt. Hoadley, near New Aiyansh, British Columbia, 55° 128' SW, 19 July 1972. One female of *Parnassius eversmanni* Ménétériés was collected. Males were observed but not collected. This represents a new species for British Columbia. It also represents a 430-mile southern extension of the species' known range in Mt. McKinley National Park and Eagle Summit, Alaska. It is not clear from the single female if this population is referable to *P. e. thor* Hy. Edwards.

Boloria epithore chermocki Perkins and Perkins (two males, two females) and *Erebia vidleri* Elwes (two females) were also collected. *Erebia vidleri* was not previously known north of Vancouver, British Columbia on the coast and Lillooet, British Columbia in the interior. Except for doubtful records from central Alaska (which have not been confirmed by the Alaska Lepidoptera Survey) and doubtful records for Smithers and Chilcotin, British Columbia, *B. epithore* was known positively only south of Lillooet, British Columbia. Thus the known range for *B. epithore* and *E. vidleri* has been extended 400 miles to the north.

Parnassius eversmanni was taken above timberline (6400 ft.) and replaced *P. phoebus* Fabricius which was just at timberline (5000 ft.). *Boloria epithore* and *Erebia vidleri* were taken at 5500 ft. elevation. At the lower elevations, *Plebejus saepiolus* (Boisduval), *Pieris napi* (Linnaeus), *Speyeria mormonia* (Boisduval), *S. hydaspe* (Boisduval), and *Papilio zelicaon* Lucas were also taken. This is a common species association for *Boloria epithore* and *Erebia vidleri* at more southern coastal localities.

In addition to the above records, one female of *Boloria epithore* was recorded at the following, more inland, locality: Hudson Bay Mountain, Ski Hill, near Smithers, British Columbia, 26 July 1972. The other two species were not seen here. This locality is near that for a doubtfully accurate record of *Parnassius eversmanni* that has been overlooked or ignored by other authors (Jones 1951, Entomol. Soc. Brit. Columbia, Occ. Pap. 1, 148 p.). Gunder (1932, Pan-Pac. Entomol. 8: 123–127) recorded *Parnassius eversmanni* as follows: Babine Range above Smithers, British Columbia, 20 July 1931, J. F. May, one female. The Smithers record for *B. epithore* (Perkins & Meyer 1973, Bull. Allyn Mus. Entomol. 11: 1–23) is the same as *Parnassius eversmanni*. Since the species *Melitaea mayi* Gunder from the same locality is of doubtful existence anywhere in North America, it was assumed that the *Parnassius eversmanni* and *Boloria epithore* were similarly mislabeled.

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GENITAL STRIDULATION IN *PSILOGRAMMA MENEPHRON* (SPHINGIDAE)

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Males of *Psilogramma menephron* (Cramer) and *Psilogramma jordana* Bethune-Baker produce sounds by rasping scales on the dorsal surfaces of the genitalic valves against needle like spines that are located on the posterior edge of the eighth tergite. There are no significant differences between the stridulatory structures of the 2 species. Temporal characteristics of the sound of *P. jordana* have been described by Robinson & Robinson (1972), and I recorded the sounds of *P. menephron* at the Bishop Museum Field Station (Wau Ecology Institute) at Wau, New Guinea.¹ Its sound differs from that reported for *P. jordana*. The conclusions of Robinson & Robinson (1972) regarding the frequency output of the stridulatory mechanism are incorrect.

The moths were taken at night at an incandescent bulb, and when grasped and manipulated in the hand, they produced sibilant tss tss sounds. These sounds were emitted in groups that were irregular in duration (from less than 1 to more than 4 seconds) and rhythm.

Analysis of the recorded sounds² reveals the following: each tss sound is composed of a variable number of acoustical units (pulses), and there is no structure within a pulse that would suggest the actual nature of the spine-scale stridulatory mechanism (Fig. 1A). The sound spectrum is continuous from 1 to about 14 kilohertz (Fig. 1B) and within this range there are no especially dominant frequencies. The time characteristics of the pulses and periods of portions of 3 pulse groups are given in Table 1. Pulse frequencies were 11.1–12.5 Hz (26.5°).

DISCUSSION

The sounds of the 2 species are similar though not identical. The pulses of *P. menephron* were emitted in groups, but no grouping is apparent in the pulse train figured by Robinson & Robinson (1972) for *P. jordana*. The pulse recurrence frequency of *P. menephron* (ca 12 Hz at 26.5°) is about 2× that of *P. jordana* (temperature unknown). Pulse length in *P. jordana* is about 2× that of *P. menephron* (0.14 versus 0.07 sec).

¹This research was performed during the 1969 Alpha Helix Expedition to New Guinea; the program was supported by the National Science Foundation under grant GB 8400 to the Scripps Institution of Oceanography.

²Recordings were made with a Uher 4000 Report-L tape recorder at 7.5 ips, and an Electro-Voice 655C dynamic microphone. Analysis was made with a Sona-Graph with an analyzing band width of 300 Hz.

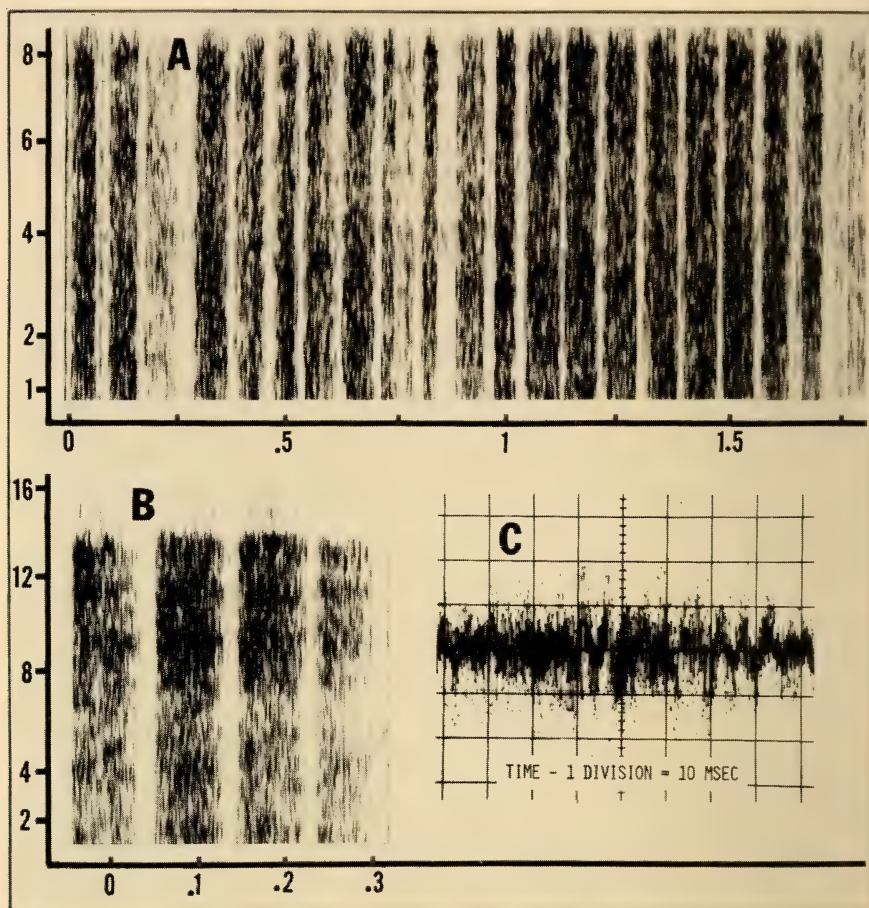


Fig. 1. Moth sounds: (A) audiospectrogram showing a long sequence of pulses (vertical axis = frequency in kilohertz; horizontal axis = time in seconds; (B) audiospectrogram with frequency and time axes doubled, showing the broad carrier frequency spectrum; (C) oscillogram showing pulse of sound with its beam deflection frequency of several thousand (estimated 10,000) per second. Recording temperature for all sounds figured was 26.5°C.

It is not possible to determine the actual mechanics of sound production at the level of spine-scale impact from simple tape recordings, as attempted by Robinson & Robinson (1972). They counted oscillographic beam deflections, compared this with counts of spines and scales, and suggested that each beam deflection was a spine-scale impact (they estimated an impact frequency of 1,430 Hz). The audiospectrogram (Fig. 1B) shows that the spectrum is continuous from 1 to at least 14

TABLE 1. Pulse characteristics of portions of three pulse groups.

Group No.	Pulse Length (sec)				Pulse Period (sec)			
	\bar{x}	Range	s.d.	n.	\bar{x}	Range	s.d.	n.
1	0.07	0.06-0.09	0.01	19	0.09	0.08-0.13	0.01	19
2	0.07	0.03-0.08	0.01	23	0.08	0.07-0.12	0.01	22
3	0.07	0.03-0.11	0.02	23	0.09	0.06-0.12	0.12	22

KHz, and no spine-scale impact frequency is evident amid the myriad of carrier frequencies. (1) The oscilloscope beam deflection is the result of averaging hundreds of frequencies at many different energy levels. (2) Even in the simple (by comparison) file and scraper stridulation of Tettigoniidae, a 1 to 1 relation does not exist between unit impact and sound output: the acoustical output of a single file-tooth impact is a complex wave of several cycles (Sugo, 1966). (3) Actually, the oscillogram given for *P. jordana* does not appear to be completely resolved into individual beam deflections. By using a fine, low-intensity beam, fast film, and a sweep speed of 100 cm/sec I was able to resolve the sound of *P. menephron* to an estimated 10,000 beam deflections/second (Fig. 1C),³ a figure of no real meaning or descriptive significance when compared with the acoustical parameters that were determined audiospectrographically.

ACKNOWLEDGMENTS

I acknowledge the many kindnesses of and assistance received from colleagues on the Expedition and friends and associates in the T.P.N.G. Among these were J. and E. Buck, M. and J. Sedlacek, and J. Wormersley and his staff of the Lae Botanical Garden. I thank T. J. Walker, J. J. Whitesell and S. M. Ulagaraj for technical advice and assistance. T. J. Walker read the manuscript. This research was performed during the tenure of N.S.F. grant GB 7407, Florida Agricultural Experiment Station Journal Series no. 5362.

³ Tektronix oscilloscope 564, 3A72 amplifier, and 2B67 time base unit; Tektronix C30 camera.

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MELITAEA PULCHELLA BOISDUVAL 1852, A REPLACEMENT NAME

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Tilden (1969) considered the name *pulchella* Boisduval a synonym of *tharos* Drury 1773. Some question was raised about this action. It was pointed out that there is in the United States National Museum, a specimen that is labelled as the type of *Melitaea pulchella* Boisduval.

W. D. Field kindly examined this specimen and stated that he considered it a specimen of *Phyciodes campestris campestris* (Behr) but agreed with my opinion that Boisduval had not described this insect in his original statement concerning *pulchella*. He expressed the belief that *pulchella* was a replacement name, since, as pointed out by Tilden (1969), Boisduval had merely cited Drury's figure as representing his *Melitaea pulchella*.

In July 1973 I was able to examine the type of *M. pulchella*. It is indeed a specimen of *Phyciodes campestris*, without locality or date labels. It is thus not possible to be sure when this specimen was selected by Boisduval. It may have been at the time of the original citation, or later.

Boisduval's statement that *Melitaea pulchella* (which he considered to be represented by figs. 5 & 6 on Plate 1 of Drury's Illust. Nat. Hist.) should not be confused with *Papilio tharos* Cramer, indicated that he gave priority to *tharos* Cramer and thus intended *pulchella* as a replacement name for *Papilio tharos* Drury.

There is no description of any insect, either here or in later references to *pulchella* by Boisduval.

It makes no difference what insect is labelled as the type of *pulchella*, since this insect so labelled is not described and so is without status. By Boisduval's own statements, *pulchella* is a replacement name for *Papilio tharos* Drury, not *Papilio tharos* Cramer.

Cramer (Tom. II p. 12, & Plate CLXIX, figs. E, F) figures *Papilio tharos* and refers to Drury, Tom. I, pl. 12, figs. 5, 6. *Papilio tharos* Drury dates to 1773, *P. tharos* Cramer to 1777.

On the basis of Boisduval's statements, *Melitaea pulchella* must be considered a synonym of *Papilio tharos* Drury, and cannot replace *Phyciodes campestris* (Behr) 1863 even though the "type" of *pulchella* is a specimen of *campestris*.

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A NEW FOODPLANT RECORD FOR *SATYRIUM KINGI* (LYCAENIDAE)

Harris (1972, Butterflies of Georgia, Univ. Oklahoma Press) reports that John C. Symmes found and reared *Satyrium kingi* (Klots & Clench) on Flame Azalea (*Rhododendron calendulaceum*) in the Atlanta, Georgia area; but that H. L. King collected *kingi* at the type locality (Savannah, Georgia), where he saw females ovipositing on a small plant not related to azalea. Moreover, King noted that he found no native azalea plants in the area around where he collected his specimens. These facts, of course, suggest that *kingi* has more than one foodplant. More recently Gatrell (1974, J. Lepid. Soc. 28: 33-37) has raised the question of the relationship between possible subspecifically distinct populations of *kingi* and differences in the choice of foodplant in these different populations. More specifically, the inference might be made that the northern (inland or upland) population not only represents a subspecies distinct from the lowland (or coastal) population, but that the northern population may feed on a different foodplant from the lowland population.

I wish to report a second foodplant for the northern population of *kingi*, horse sugar tree, *Symplocos tinctoria* (L.). On 10 May 1966, on a ridge near the Chattahoochee River just north of Atlanta, Georgia, I found three larvae that were unfamiliar to me on a single bushy plant. The three larvae, along with an ample supply of the foodplant, were collected; and the larvae were reared at my home in Atlanta. On 17 May 1966 the first larva pupated and the other two pupated several days later. The first adult emerged on 28 May 1966 and the other two emerged several days later. Upon identifying the specimens as *Satyrium kingi*, I pressed a branch of the foodplant (which was still quite fresh even 18 days after it had been collected). The foodplant was later identified as horse sugar tree by Dr. Robert Godfrey, Department of Botany, Florida State University. The larvae I reared fit the general description given by Harris (loc. cit.), and were similar in appearance to a single larva of *Satyrium liparops* (Boisduval & Le Conte) which I collected almost a year later (2 April 1967) on wild cherry (*Prunus* sp.) less than 300 meters from the spot where the *kingi* larvae were found. The *liparops* larva pupated on 6 April 1967 and the adult emerged on 16 April 1967.

Single adult specimens of *kingi* were collected in the same general area of upland hardwoods on 3 June 1966 and 9 June 1967. Other members of the family Lycaenidae that I collected at the same location in 1966 and 1967 included *Chrysophanus titus mopsus* (Hübner) on 9 June 1967; *Satyrium edwardsii* (Grote & Robinson) on 9 June 1967; *Strymon melinus* (Hübner) on 9 June 1967; *Satyrium calanus falacer* (Godart) on 3 June 1966; *Calycopis cecrops* (Fabricius) on 17 April 1967; *Atlides halesus* (Cramer) on 13 March 1967; and *Callophrys augustinus croesides* (Scudder) on 13 March 1967.

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THREE NEW UNITED STATES RECORDS (LYCAENIDAE AND
NYMPHALIDAE) AND OTHER UNUSUAL CAPTURES
FROM THE LOWER FLORIDA KEYS

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A year's collecting in the Lower Florida Keys during 1972-1973 turned up three species of butterflies not previously recorded for the United States and several other uncommon and unusual captures. It is difficult to estimate on the basis of the present records how extensively the new species have established themselves, but at least one has a well established colony.

Electrostrymon angelia angelia (Hewitson)

(Fig. 1)

This species was first captured in Key West on 6 April 1973 and was taken continuously each month until my departure in November 1973. *E. angelia* was found in and around a tropical hardwood area and was attracted to the blossoms of Brazilian Pepper *Schinus terebinthefolius* (Raddi) and Seagrape *Coccoloba uvifera* (L.). When these blossoms were no longer available, the butterflies were found perched on leaves at the edge of the wooded area or in open areas within the trees, and were almost always perched in areas of shade or broken sunlight rather than in direct sunlight. A preference for shaded areas was especially noticeable in the summer months, whereas in April and again in October-November perches were more likely to be in areas of scattered sunlight.

E. angelia was not common and seldom were more than 3-5 specimens captured at one location. However, during the end of April as many as 20-25 specimens were seen flying about in clearings and open areas on clear, hot afternoons. This hairstreak did not seem to prefer any particular height for perching, rather the nature of the foliage and the amount of sunlight seemed to determine the perch.

Harry Clench of the Carnegie Museum has determined that the Key West population belongs to the nominate populations found on Cuba and not to *E. angelia dowi* (Clench) which occurs in the Bahamas. Apparently, the colony on Key West is well established and should remain barring destruction of the area. Specimens are being deposited in the collections of the Carnegie Museum, Pittsburgh, Pennsylvania, and the Allyn Museum, Sarasota, Florida.



Fig. 1. *Electrostrymon angelia angelia* (Hewitson), ♂, upper (left) and under (right) surfaces (collected at Key West, Munroe Co., Florida, 30 May 1973, R. A. Anderson leg.) 2.7×. Allyn Museum photo nos. 110773-15/16.

Strymon limenia (Hewitson)

(Fig. 2)

Two males and one female of this species were captured on 23 December 1972 on Big Pine Key on the flowers of Spanish Needles (*Bidens pilosa* L.). Had I not had previous experience with *S. limenia*, I'm sure I would have overlooked it due to the similarity in pattern between this species and the more common *S. columella modesta* (Maynard). A single male *S. limenia* was also captured in Key West on 23 May 1973 when resting near blossoms of a Brazilian Pepper. Subsequent



Fig. 2. *Strymon limenia* (Hewitson), ♂, upper (left) and under (right) surfaces (collected at Key West, Munroe Co., Florida, 23 May 1973, R. A. Anderson leg.). 2.7×. Allyn Museum photo nos. 110773-17/18.

collecting in Key West and on Big Pine Key did not produce additional specimens. Steve Roman of Orlando, Florida has reported (in litt.) that he found a male *S. limenia* dated 3 April 1971 in his series of *S. columella* from Big Pine Key.

The known records for this species cover a period of two years and two Keys which are thirty-five miles apart. Perhaps this hairstreak is established on the Keys between the known locations as well as on other Keys toward the mainland, and has heretofore escaped detection due to its similarity to *S. columella*. One male and one female have been deposited in the collection of the Allyn Museum.

Anartia lytrea (Godart)

(Fig. 3)

A fresh male of this species was captured on 22 February 1973 in Key West. Harry Clench has mentioned (pers. comm.) that he has seen another specimen of *A. lytrea* from Big Pine Key captured in 1972. These two records, thirty-five miles apart, suggest the possibility of an established colony in the Lower Keys. The specimen from Key West was flying in an open wooded area and conveniently landed on the ground where it was captured. This particular locality was frequently visited but no additional specimens were seen. Lee Miller of the Allyn Museum has indicated (pers. comm.) that the specimen from Key West does not match the description of *A. lytrea chrysopelea* (Hubner) from Cuba and therefore the proper subspecific determination has not been made at this time. My specimen has been deposited in the collection of the Allyn Museum.

Chlorostrymon maesites maesites (Herrich-Schaffer)

Twenty-seven specimens of this rare hairstreak were taken in Key West during the months of May through September 1973. Although there are captures for each month during this time, most of the specimens were captured from the last week in May to the middle of June. This peak in numbers occurred when the Brazilian Pepper and Guamachil Apes-earring (*Pithcellobium dulce* Benth.) were in bloom. Blossoms of *Pithcellobium* were especially attractive. Although some *C. maesites* were captured while visiting the blossoms of these two trees, most were found perched on leaves of other nearby trees, and always on perches in direct sunlight. No more than half of the individuals seen were captured because they constantly changed perches, their flight being rapid and difficult to follow, and frequently their perches were out of range of my long-handled (12 ft.) net. However, some specimens were taken



Fig. 3. *Anartia lytrea* (Godart), ♂, upper (left) and under (right) surfaces (collected at Key West, Monroe Co., Florida, 22 February 1973, R. A. Anderson leg.). 1.5 \times . Allyn Museum photo nos. 110773-13/14.

from perches as low as 3–6 ft. above the ground. Its small size and green underside often made this hairstreak extremely difficult to see when resting on foliage. Despite the moderate number of *C. maesites* taken, it was not common on Key West and the individuals seen and captured were the result of frequent visits to the known colonies for a period of several months.

Marpesia eleuchia (Hubner)

A male of this Antillean Dagger Wing was captured on 14 October 1973 on Sugarloaf Key. It was attracted to the blossoms of a Brazilian Pepper and was flying with *M. petreus* (Cramer) which was common at the time. The specimen was in good condition and did not look as though it was a visitor from outside the Keys. Subsequent visits to the area during the rest of October did not locate additional specimens. The specimen has been deposited in the collection of the Allyn Museum.

Eurema boisduvaliana (Felder)

One fresh female was taken on 20 September 1973 in an open wooded area in Key West. The capture was made in a frequently collected area and was the only example of this species seen. The specimen has been deposited in the collection of the Allyn Museum.

Erynnis zarucco zarucco (Lucas)

Approximately twenty percent of the specimens seen from the Key West area have a white fringe on the hindwing, which is characteristic

of *E. zarucco funeralis* (Scudder and Burgess). The white fringe is not as extensive as in typical *E. z. funeralis* but is intermediate between it and typical *E. z. zarucco*. Most of the specimens with significant white fringes on the hindwing were females. Interestingly, Kimball (1965, Lepidoptera of Florida) records four male *funeralis*-like *E. zarucco* from northern Florida.

ACKNOWLEDGMENTS

I wish to thank Dr. Lee Miller of the Allyn Museum for making the photographs accompanying this article, and Harry Clench of the Carnegie Museum for his subspecific determination of *E. angelia*. My appreciation also goes to Stan S. Nicolay and Dr. J. Bolling Sullivan for their suggestions and critical reviews of the manuscript.

HYBRID BETWEEN *COLIAS EURYTHEME* AND *COLIAS HARFORDII* (PIERIDAE) CAPTURED IN CALIFORNIA

The first recorded hybrid between *Colias eurytheme* (Boisduval) and *Colias harfordii* (H. Edwards), a perfect male, was captured by the author near Cachuma Creek, San Rafael Mountains, Santa Barbara County, California. The date of capture was 1 May 1970. This locality is approximately two miles south of Cachuma Saddle Ranger Station, and five miles southeast of Figueroa Mountain. Adults of both *eurytheme* and *harfordii* have been observed flying in the San Rafael Mountains, and larvae of both species have been found on *Astragalus antisellii* (Gray) in Oso Canyon. The specimen has been placed in the Peabody Museum of Natural History, at Yale University, New Haven, Connecticut.

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A NEW SUBSPECIES OF *LETHE APPALACHIA*
(SATYRIDAE)

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The appalachian eyed brown, *Lethe appalachia* (R. L. Chermock), was first described as a subspecies of *Lethe eurydice* (Johansson) ranging from the mountains of West Virginia southward through the Appalachian Mountains and into northern Florida. It was also mentioned as occurring in the coastal swamps of Virginia and South Carolina (Chermock, 1947).

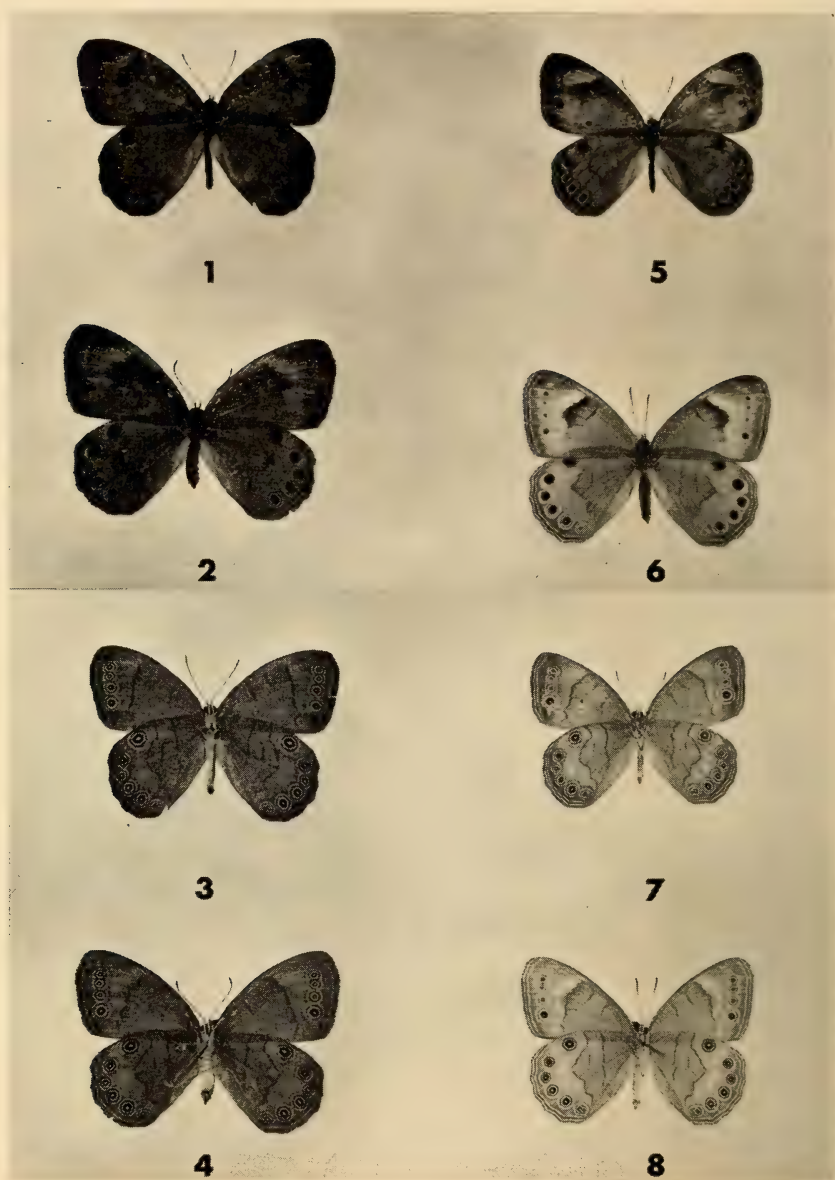
Cardé et al. (1970) recognized *L. appalachia* as a distinct species that is broadly sympatric with *L. eurydice* but occurring mainly in swamp forests, shrub swamps and forest-edge ecotones, while *eurydice* occurs in open marshes and sedge meadows. Cardé et al. (1970) gave the range of *appalachia* as Maine to northern Florida and westward to South Dakota and Alabama.

The type locality of *L. appalachia appalachia* is Brevard, Transylvania County, North Carolina in the area of Conneestee Falls. Nominate *appalachia* until recently had not been recorded from very many localities in the southern states. The known southern limit of the species was extended in 1972 by the discovery of a colony in a swampy forest in west central Florida, two miles south of Zephyrhills, Pasco County (Brown, 1973). The western range of *appalachia appalachia* was extended when it was found in Tishomingo County, Mississippi, by Mr. C. T. Bryson in May 1971.

The northern populations of *L. appalachia* ranging from Massachusetts and Maryland westward to Wisconsin and Illinois were found to be sufficiently distinct from southern nominate *appalachia* populations to warrant a subspecific name. We name this new subspecies for Mr. Irwin Leeuw of Cary, Illinois, who first drew it to our attention through specimens that he collected in Michigan.

***Lethe appalachia leeuwi* (Gatrelle and Arbogast), new subspecies**
(Figs. 5-14)

Male: Forewing radius: 21-26 mm, mean 24.2 mm in type series. *Dorsal surface:* ground color of both primaries and secondaries grayish brown as in nominate sub-



Figs. 1-4. *Lethe appalachia appalachia* (R. L. Chermock): 1 & 3, male, Table Rock State Park, Pickens County, South Carolina, 3 July 1972; 2 & 4, female, McClellanville, Charleston County, South Carolina, 30 May 1970.

Figs. 5-8. *Lethe appalachia leeuwi* (Gatrelle & Arbogast), new subspecies: 5 & 7, holotype, male, Wakelee, Cass County, Michigan, 24 July 1972; 6 & 8, allotype female, Wakelee, Cass County, Michigan, 4 July 1957.

species (Figs. 1 & 5), but lighter and with more contrast between the various shades. Apical and marginal areas dark; narrow dark bar at end of cell and dark postmedian band of irregular width extending from R1 to CU1 and CU2. Area between this band and the row of ocelli light. Basal and discal areas an intermediate shade. Contrast between discal and limbal areas of secondaries more pronounced than in nominate *appalachia* and light rings surrounding ocelli usually more conspicuous. *Ventral surface*: ground color lighter and much less uniform than in nominate subspecies (Figs. 3 & 7) and lacking purplish cast. On both primaries and secondaries a broad band of light brown tinged with white extends from near costal margin to second anal vein. This band contrasts markedly with darker basal and discal areas. It is bordered proximally on both wings by the postmedian line, and on the primaries bordered distally by the row of ocelli. On the secondaries it surrounds the first ocellus and is bordered distally by the remaining ocelli. **Female**: Forewing radius: 26–27 mm, mean 26.5 mm. As in male but lighter and with even more contrast between the various shades. Light area on dorsal surface of primaries very prominent, very often nearly white and extending from costal to inner margin (Figs. 2, 4, 6 & 8). Nominate *appalachia* females may in some individuals show markedly lighter subapical areas above and lighter limbal areas below than female figured though never as in *leeuwi* females.

Holotype male: Wakelee, Cass Co., Michigan, 24 July 1972, *leg.* Irwin Leeuw; deposited temporarily in the senior author's collection.

Allotype female: Wakelee, Cass Co., Michigan, 4 July 1957, *leg.* M. C. Nielsen; deposited in the collection of Michigan State University.

Paratypes: Michigan. *Cass County*: 2 males, 30 June 1972; 2 males, 24 July 1972; 3 males, 3 July 1973 (*leg.* Irwin Leeuw); 1 male, 16 July 1967; 1 female, 16 July 1970; 6 males, 15 July 1972 (*leg.* P. J. Conway); 1 male and 1 female, 7 July 1971; 2 males, 9 July 1971 (*leg.* R. R. Irwin); 1 male (abdomen missing), 1 July 1973 (*leg.* M. G. Seaborg). *Clinton County*: 4 males, 16 July 1972 (*leg.* M. C. Nielsen). *Lenawee County*: 1 male, 20 June 1970; 1 male, 15 July 1973; 1 female, 22 July 1973 (*leg.* M. C. Nielsen). *St. Joseph County*: 1 male, 12 July 1972 (*leg.* M. C. Nielsen). *Barry County*: 1 male, 12 July 1956 (*leg.* R. L. Fischer); 1 male, 14 July 1973 (*leg.* M. C. Nielsen). *Montcalm County*: 1 male, 3 July 1952; 1 male, 9 July 1953 (*leg.* M. C. Nielsen). *Wayne County*: 1 male, no date (*leg.* A. W. Andrews); 1 female, 10 July 1943 (*leg.* M. C. Nielsen). *Washtenaw County*: 1 female, 18 July 1964 (collector unknown).

The 31 males and 6 females of the type series are deposited in the following collections: Michigan State University, Illinois Natural History Survey, P. J. Conway, M. C. Nielsen, R. R. Gatrelle, R. T. Arbogast, Irwin Leeuw and M. G. Seaborg.

In addition to the type series, material referable to *leeuwi* was examined from Devil's Lake State Park, Wisconsin; Illinois Beach State Park, Lake County, Illinois; Paulding and Lake Counties in Ohio; Bedford and Reading, Pennsylvania; and Martha's Vineyard, Massachusetts. Five males from Baltimore, Maryland which we examined were darker than typical *leeuwi*, but were still closer to the new subspecies than to nominate *appalachia*.

Eighty specimens were examined in the course of this study of nominate southern *appalachia*. We were not able to examine specimens of *L. appalachia appalachia* from the type locality, Connestee Falls, near



Figs. 9-14. *Lethe appalachia leeuwi* (Gatrelle and Arbogast), new subspecies: 9 & 12, paratype male, Montcalm County, Michigan, 3 July 1952; 10 & 13, paratype male, Lenawee County, Michigan, 20 June 1970; 11 & 14, female, Paulding County, Ohio, 11 July 1971. These three specimens show the variation within the new subspecies.

Brevard, North Carolina, but we did examine material from Table Rock State Park, Pickens County, South Carolina which is just 13 miles south of Brevard. We found these specimens to agree in every respect with Chermock's description of *appalachia*. A note of interest here is that the type locality, Connestee Falls area, is now undergoing drastic change. The area is being turned into a "resort" community and housing development. The drastic changes in the environment may well lead to the extinction of *appalachia* in that area. The specimens from Table Rock, South Carolina are of the same phenotype as those from Brevard and unless a colony is located closer than 13 miles to the type locality, the Table Rock populations may be the closest thing to topotypes available to the taxonomist. The specimens which we examined of nominate *appalachia* were from the following areas. South Carolina: Pickens, Dorchester and Charleston Counties. Georgia: Fannin and Cherokee Counties, and the Atlanta area. Florida: Pasco County. Mississippi: Pontotoc, Lee, Lafayette, Choctaw, Oktibbeha, and Winston Counties. All the specimens from these localities closely resembled the material from Table Rock except that the specimens from Pasco County, Florida averaged somewhat darker.

Our thanks go to the many persons who loaned us material for examination and who helped us with their ideas.

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CHARLES RUDKIN COLLECTION AT THE UNIVERSITY OF CALIFORNIA, IRVINE

The Charles Rudkin collection of Lepidoptera has been acquired by the Museum of Systematic Biology, University of California, Irvine. The collection contains over 10,000 mounted specimens (in modified Riker Mounts), primarily Rhopalocera. The collection is especially rich in California material, but also contains a fair amount of material from southeastern Arizona and the South Pacific. Nearly all specimens were collected from 1930-1945. Rudkin's field notebooks and other memorabilia will accompany the collection.

LARRY J. ORSAK, *Museum of Systematic Biology, School of Biological Sciences, University of California, Irvine, California 92664.*

BOOK REVIEWS

THE MOTHS OF AMERICA NORTH OF MEXICO INCLUDING GREENLAND, by R. B. Dominick et al., editors. E. W. Classey Ltd., and R. B. D. Publications Inc. Distributed in North America by Entomological Reprint Specialists, P.O. Box 77971, Dockweiler Station, Los Angeles, California 90007.

One of the greatest needs of students of the Lepidoptera of North America has been a definitive work on our moths, which number in excess of 10,000 species. It is practically impossible to accurately name many of the species, with the exception of some genera and a few higher groups that have been recently studied; these revisionary studies are often scattered in the literature and are not necessarily easily available to all collectors. Now this need is being filled most adequately with the series of definitive studies that will make up this series. A total of over 50 fascicles are planned, with three or four to be published each year; hopefully the task will be completed in the next 12 years or so.

Each fascicle may cover several small families, one family, or a part of a large family, and in itself, is a taxonomic revision of the group being covered. New taxa of all ranks are described where needed; old ones are redescribed. Keys are provided to help in identification. Each species account includes a reference to the original description and to synonyms when present. Each species is diagnosed, its variation discussed, and its distribution, habitat, and whatever is known about its life history and foodplants given. Genitalia are described, and figured when pertinent. In addition, each species, its subspecies and color variants are illustrated in full color and natural size; the smaller species are being enlarged.

A standard format is being used throughout the series. The one exception is in the usage of subspecific names. The board of directors, including the four authors that have published fascicles to date, could not agree on this problem; Ferguson and Munroe use this concept, while Franclemont and Hodges do not. Ferguson and Franclemont, in their respective fascicles reviewed below, outline the pros and cons of the question. Unfortunately, Hodge's work appeared before this subject was clarified; the reader, not realizing this, may be puzzled by the way the taxa are handled.

Each fascicle is a sumptuous example of printers' art. Every one is of large size, beautifully printed on excellent paper, and contains some of the best color plates ever printed of our North American moths. To produce all this entails great expense; consequently the price per fascicle is relatively high. However, considering the above factors, plus the fact that this series will be the standard source of reference for generations to come, I know that this is money well spent. (In some ways, the Moths of North America is comparable to the *Biologia Centrali-Americana* and Seitz' *Macrolepidoptera of the World*; have you tried pricing or even finding copies of these to buy recently?)

This publication is being called the definitive work on our North American moths, and I try to judge the individual fascicles according to this simple definition. To achieve this status each author should know the group thoroughly, not only in North America but in other parts of the world, be thoroughly knowledgeable about the pertinent literature, have examined the types of valid names and synonyms (and designating lectotypes where needed), and studied the bulk of specimens in this country. It is also preferable to have authors that have spent considerable time, over the years, working with the group prior to publishing on it; this has not always been possible—there just aren't enough competent specialists to properly cover each and every group of the moths.

Fascicle 21. SPHINGOIDEA: SPHINGIDAE, by Ronald W. Hodges. 1971. xii + 158 p., 16 pls. (14 in color), 8 halftones, 19 text figs.

The text on the hawkmoths is a thoroughly competent piece of popular writing on this group of mostly large-sized moths, numbering 115 species in the area covered. No one should have very much trouble determining the different species in this family. Hodges does not believe in the subspecies concept; unfortunately he did not mention this matter in the introduction to his paper. This will cause some confusion; geographic variation is discussed within the different species, but the names that have heretofore been used in the subspecific sense are merely listed in the species synonymies.

Hodges uses as a higher classification one apparently modified from Carcasson, thus differing from both McDunnough's 1938 Check List and Forbes' 1948 Lepidoptera of New York; the latter two were based primarily on Rothschild and Jordan (1903). For many readers it may be the first time they have been introduced to this new higher classification; it would have been helpful if Hodges had gone into greater detail comparing the two, amplifying the reasons for this change.

The listing of the supraspecific categories is followed by a key to the genera; Hodges does not have a key for the subfamilies or tribes, although they are defined in the text. This, in turn, is followed by "partial" keys to the genera based on the pupae (after Mosher, 1918) and on the mature larvae (after Forbes, 1911). It is possible that both the latter could have been modernized with relatively little effort.

In my opinion, this fascicle does not attain the status of a "definitive work." If Hodges had taken the time to visit the American Museum of Natural History, for instance, he would have added one or two more species to the work; additional distributional data and information on flight periods would have been added for at least 30 species—almost one-fourth of the number covered in his work. There are some two dozen errors in the bibliographical citations, either in the references themselves or incorrectly giving the original combination for the names. At least two references to early stages and foodplants were overlooked.

Notwithstanding this list of criticisms, the paper is the best one ever to appear on our North American sphingids, and I would strongly advise anyone interested in the fascinating group to obtain a copy.

Fascicle 20.2. BOMBYCOIDEA: SATURNIIDAE, by Douglas C. Ferguson. Part 2A, Citheroniinae, Hemileucinae (in part); 1971, p. 1-153, pls. 1-11 (color), text figs. 1-19. Part 2B, Hemileucinae (in part), Saturniinae; 1972, p. 154-275 + xxi, pls. 12-22 (color), text figs. 20-30.

This large family is basically tropical and subtropical in distribution, with about 65 species occurring in America north of Mexico. Ferguson did a much more thorough job of research and study than did Hodges; this is quickly recognizable when one reads the text. The last is excellently done; in fact, in my opinion it is one of the best written and most complete studies I have had the pleasure of reading, as Ferguson did an excellent job in combining the popular and scientific aspects of the subject. Of particular value is the effort that was made to fully explain many of the "sticky" problems in this group; it is such attention to detail that increases the value of this publication.

Ferguson basically follows the suprageneric classification of Michener (1952), deviating mainly in raising the appropriate subgenera to full generic status in most cases. Keys are presented to the subfamilies based on the adults, last instar larvae, and pupae (after Mosher, 1916); within each subfamily there are similar keys to the included genera. Special emphasis is given to life histories, foodplants, and the morphological characters of the larvae and pupae.

The bibliographical references and text are relatively free of mistakes and omissions. This fascicle indeed lives up to the advance billing of a definitive work.

Fascicle 13.1. PYRALOIDEA (IN PART), by Eugene Munroe. Part 1A, Scopariinae, Nymphulinae; 1972, p. 1-134. Part 1B, Odontiinae, Glaphyriinae; 1972, p. 135-250. Part 1C. Evergestinae; "1973" [1974], p. 251-304 + xx, pls. 1-13 (color), A-K (halftones).

Munroe has spent more than 25 years studying the Pyraloidea in general and the North American fauna in particular. He has done field work in practically every part of continental North America, and has visited most of the major collections and institutions in this area. His studies have taken him throughout Europe and to their museums, to Africa and to tropical America. He has built up an encyclopedic knowledge of the world fauna of the pyralids and, based on this, is setting forth the first comprehensive manual for the identification of the North American species of all families and subfamilies of the Pyraloidea. The system of classification he is proposing for our fauna is considerably different from what we have had before, with the introduction of subfamilies and tribes that are new to us. Four families are involved; one of these, the Pyralidae, is divided into 16 subfamilies. Part 1A contains the definition of the superfamily and of the Pyralidae; keys are provided to separate the families and subfamilies of the previously-mentioned family. Five of the subfamilies are covered in fascicle 13.1; each group has keys to the genera and species (when more than one is known). A number of tribes, genera, species, and subspecies are described as new. In a few cases Munroe may be splitting the taxa a bit too thin. Some are admittedly, "perhaps not really worth separating," as in some of the genera of Evergestinae, where the only differences are in the variously-shaped frontal prominences on the head. Similarly, he recognizes as distinct some species that are apparently morphologically indistinguishable except for differences in wing color only.

As in the other parts of this series, each species and subspecies is illustrated on the color plates. For the great majority, it is the first time they have been figured. The quality of some of these color plates does not seem to me to be quite as good as those in the other fascicles, but this is undoubtedly due to the smaller size of the moths, more specimens per plate (with some distracting pins being shown for the first time), and the magnification. Nevertheless, these color plates continue to be the best ever produced of our North American moths.

Parts 1A and 1B each have a modest number of mistakes in the bibliographical references; 1C is greatly improved, as I did not note a single one. Munroe is to be congratulated for designating lectotypes where necessary. I would like to see the work on types extended one additional step, with the depository of each being designated. This should not appreciably increase the length of the reference section of each name, and it would be an invaluable aid to present and future workers.

Munroe is to be congratulated for a piece of original work excellently done; I am eagerly looking forward to succeeding fascicles in his monumental work on our Pyralidae.

Fascicle 20, Part 1. MIMALLONOIDEA: MIMALLONIDAE, AND BOMBYCOIDEA: APATELODIDAE, BOMBYCIDAE, LASIOCAMPIDAE, by John G. Franclemont. 1973. viii + 86 p., 11 color pls., 22 text figs.

Franclemont erects the superfamily Mimallonoidea for the single anomalous family Mimallonidae (Lacosomidae of McDunnough's Check List, 1938). The four included species are placed in three genera; of these, one genus and one species are described as new. Three families are included in this section of the Bombycoidea; all are small-sized in our area. The Apatelodidae (Zanolidae of McDunnough, 1938) contains two genera and five species; the Bombycidae contains only the introduced silkworm, *Bombyx mori* (Linnaeus); and the Lasiocampidae encompass 12 genera with about three times that number of species.

The main contribution in this fascicle is a new suprageneric classification of the

Lasiocampidae, which is divided into three subfamilies and one of these into two tribes. The Neotropical representatives of this family are relatively unknown and much work needs to be done with them; when properly studied it will be interesting to find out how these species and genera fit into Franclemont's classification.

There are only two relatively large genera in our Lasiocampidae. One of these, *Malacosoma*, has recently been revised by Stehr & Cook (1968); this work is closely followed in the fascicle, and their key to the mature larvae, as well as pls. 1 and 2 of larvae, are taken directly. Throughout the discussion of this genus Franclemont continually refers to "the revision of the American species by Stehr (1968)." While it is true that Stehr did most, or all, of the work in that revision, it is assumed that Franclemont worked from the published revision; if this is so, then the correct reference should read Stehr & Cook, 1968, as this is how the results were published.

The other large genus is *Tolyte*, and this represents the main original research on a specific level by Franclemont in the fascicle. He admits, in the Introduction, that there are a number of problems here, particularly in western North America, and that he did not have the time to try to solve them properly. Independently, and prior to the publication of this fascicle, I had studied our collection of this genus, mainly utilizing genitalic dissections. Franclemont's treatment of the few eastern species appears sound; in the western part of the continent his handling of the species leaves quite a bit to be desired — he, indeed, did not solve all the problems. One thing that might have helped him would have been to study the extensive material at the American Museum of Natural History. I cannot help but get the feeling that Franclemont has only hazy notions about distributional patterns of western species. For example, he gives the distribution of *Tolyte dayi* Blackmore (on p. 44) as British Columbia, Washington, and Montana; yet, on pl. 3, fig. 34, he illustrates a specimen of *dayi* from Santa Cruz Co., California, which is a good 700 miles away. I had trouble comparing the drawings of the female genitalia, particularly those of the sterigma, with my dissections. Franclemont may have completely overlooked one character in the female, as nowhere did I find reference to the nature of the scales in the anal tuft; these may have good specific characters.

One point that surprised me was Franclemont's apparent ignorance of the literature. Three examples: he gave incorrect designations for the type species of both *Tolyte* and *Artace*; for *Tolyte dayi* he states that "the larva has not been described," but in reality the description has appeared twice. There are at least five other bibliographical errors.

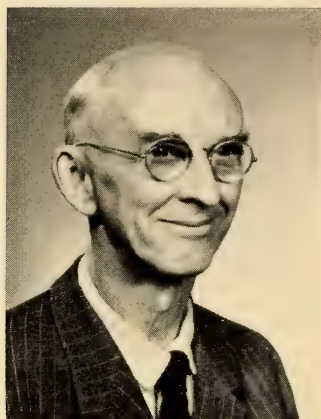
The subspecies problem is admirably handled in this fascicle. Franclemont gives his views on why he does not utilize this concept in the Introduction. In the discussion of variability within the individual species he clearly points out when geographic variation occurs and if a name is available for that population. However, he insists on continually using the unmodified word "race" in place of subspecies or geographic subspecies. His term is not recognized by the Code; it always strikes me that this is a quaint Victorian term that is more suitable for the Olympics than for inclusion in a major entomological systematic work being published today.

Over-all, this fascicle has many excellent points. However, it also has a surprising number of drawbacks for the coverage of such a small group that entailed relatively little original research. I can hardly consider this as a definitive piece of work.

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OBITUARY

ALEX K. WYATT (1878-1971)



An entomological career of three-quarters of a century was brought to a close with the death of Alex K. Wyatt in Chicago, Illinois on May 14, 1971. At first known to the entomological world as Alexander Kwiat, he changed his name to its present form in 1918. He was born in Chicago, December 28, 1878, the son of German immigrant parents. He married Eva Stuhlfaut in September, 1908 and to them were born three children: Elva A. (Mrs. J. T. Mauer) of Chicago, Lillian M. (Mrs. Leslie Skutle) of Kent, Ohio, and Harold, who died in April, 1930 at the age of ten.

Mr. Wyatt was educated in the public schools of Chicago. He graduated from Newberry grammar school in 1892 and for two years attended North Division High School, whose principal was Oliver S. Westcott, himself an entomologist. Following eight months' attendance at business college he secured a position as office boy with a real estate firm in 1895. Except for two years in the office of a fire insurance company, the rest of his business career was spent in the real estate field. He operated his own industrial real estate brokerage business, from which he retired in 1956.

His interest in Lepidoptera arose at an early age, and developed during his second year in high school, when he learned collecting and preserving techniques under the tutelage of Westcott. Beginning with a general

insect collection, he soon found this to be too great an undertaking, and disposed of all his specimens except Lepidoptera by giving them to C. T. Brues and A. L. Melander, who were also pupils of Westcott and who later became prominent professional entomologists. His earliest collecting was done in Chicago's Lincoln Park before butterfly nets were prohibited there. He soon became acquainted with John L. Healy, Arthur J. Snyder, W. E. Longley, James Tough and others who were associated with the Chicago Academy of Sciences. This group organized itself in 1897 as the Chicago Entomological Society, which Wyatt served as secretary during most of its existence. He was also a charter member of the Lepidopterists' Society and of the Entomological Society of America.

Wyatt was the last survivor of Chicago's fraternity of Bohemian collectors, which included Paul Vollbrecht, Berthold Neubarth, Charles Krueger, Arthur Herz and others, most of whom belonged to a German social club with headquarters near Lincoln Avenue and Belmont Street. Its members made regular collecting trips to such favorite Chicago area localities as Palos Park and Schiller Park, Illinois and Hessville (now part of Hammond), Indiana. Also among his close friends were Murray O. Glenn, John G. Franclemont, and the late Otto Buchholz, Emil Beer and Henry Ramstadt. Most of Wyatt's collecting was done near Chicago, but he made collecting trips at various times to Oregon and Washington, Kentucky and Tennessee, and several to Florida.

Following his retirement from business, Wyatt in 1957 donated his collection to the Field Museum of Natural History, Chicago. It consisted of 24,644 specimens including about 5000 species and varieties, as well as holotypes of taxa he described and an undetermined number of paratypes. 2295 specimens representing some 500 species were butterflies. At the same time he joined the Museum staff as a research associate in the Division of Insects. He personally incorporated his collection into that of the Museum, while supervising a general rearrangement of the latter.

In 1959 he became afflicted with heart disease and cataracts on both eyes. He and his wife spent the winter of 1959-60 in St. Petersburg, Florida. There he collected at store fronts almost every evening, securing a total of more than 2500 specimens during six months, all of which were deposited in the Museum. In the summer of 1960 he underwent surgery for the cataracts, and although the operation itself was successful, retinal complications followed and his vision deteriorated to the extent that he could no longer drive a car nor determine specimens, which brought to an end his collecting activities. Following the death of his wife in November, 1962 he made his home with his daughter, Mrs. Mauer. De-

spite his advanced age and physical handicaps he continued to visit the Museum fairly regularly for several more years.

Wyatt was particularly interested in *Holomelina* and *Papaipema*, Heliothinae, and in life history research and the collecting and rearing of larvae. His many contributions to the knowledge of the life history of moths are found in the literature under his own authorship as well as that of others. He was adept at fashioning his own equipment, much of which continues in use today. One of his outstanding characteristics was an unfailing willingness to aid and encourage younger lepidopterists, among them this author.

Lepidopterous taxa named in Wyatt's honor include *Lycaena thoe* ab. **wyatti** Gunder, *Lasionycta wyatti* Barnes and Benjamin, *Papaipema inquaestia* form **wyatti** Barnes and Benjamin, and *Eteobalea wyattella* (Barnes and Busck).

The author acknowledges with sincere appreciation the cooperation of Mrs. Elva Mauer, Mr. Murray O. Glenn, and especially Mr. Henry Dybas, Curator of Insects at the Field Museum, in the preparation of this article. The accompanying photograph, taken in 1961, was provided through the courtesy of that institution. Portions of the article were adapted from unpublished autobiographical material of Wyatt in the museum's archives.

BIBLIOGRAPHY OF ALEX K. WYATT

In addition to the papers listed below, Wyatt was the author of minutes of the Entomological Section of the Chicago Academy of Sciences, which were published from time to time in the Entomological News. His earliest papers appeared under the name of Alexander Kwiat.

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A NOTE ON THE PHENOLOGY OF *PLEBEIUS ACMON* (LYCAENIDAE)

Microgeographic differences in physiological responses to seasonality among con-specific populations are of potentially great evolutionary interest. In his review of host specificity in *Plebeius acmon* Westwood & Hewitson (Lycaenidae) and its relatives, Goodpasture (1974, J. Lepid. Soc. 28: 53-63) mentioned an apparent case of this sort. According to Goodpasture, *acmon* begins flying in March near Monticello Dam in the Vaca Mountains (central California Inner Coast Ranges), where it has a seasonal succession of hosts—but not until June at Putah Creek near Davis, on the floor of the Sacramento Valley 25 miles to the east. Goodpasture claims that *acmon* has only one host at Putah Creek, the summer leguminous annual *Lotus purshianus* Benth., and that its late appearance there (which he documents by reference to two years' field experience, years not specified, and the dates of museum specimens) is thus adaptive. Laboratory stocks from the two localities are stated not to differ in their responses to photoperiod in the induction of larval diapause. Without any experimental evidence, Goodpasture concludes that "seasonal flight data indicate that these populations differ markedly in response to conditions initiating breaking of diapause" (emphasis added). If real, this situation would deserve careful genetic study. However, it is not.

Monticello Dam controls the flow in Putah Creek. Below the dam the creek bed is virtually dry in mid- to late summer, when *Lotus purshianus* and *P. acmon* (and *Everes comyntas* Godart, which also feeds on this plant) are at their peak there. Winter flow is variable from year to year, depending on rainfall. In dry years there is little surplus water to be released downstream, and at Davis little disturbance of *acmon* breeding sites occurs. In wet years enormous volumes of water move through the bed of Putah Creek from levee to levee at high velocity, stripping the organic litter from some places and burying it in silt in others. Under such conditions successful overwintering of *acmon* larvae is very unlikely. This obvious influence on the apparent phenology of *P. acmon* is borne out for the 1972 through 1974 seasons.

Rainfall for the 1971/72 water year (July 1 through June 30) at Davis was 8.60 inches, *vs.* a 100-year mean of 16.80 inches. This was the lowest seasonal rainfall since 1938/39 and the third lowest of record. The bed of Putah Creek was nearly dry all winter. *P. acmon* was flying at Davis on 4 March 1972. Putah was not collected until 17 April, and on that date *acmon* was numerous. It was subsequently seen on every visit to Putah in spring, *i.e.* 19 and 25 April, and 1, 12, 23, and 28 May, the last two dates representing the beginning of the second generation.

The rainfall at Davis for 1972/73 was 27.65 inches, the heaviest since 1957/58 and the fourth heaviest of record. Putah Creek was in flood much of the winter, and the litter in *acmon* breeding areas—which had been left in place the preceding

year—was nearly all swept away. Although *acmon* was flying on the floor of the Sacramento Valley under non-floodplain conditions as early as 14 March 1973, it was not seen at Putah until 11 June. This pattern was repeated in 1974 after the wet 1973/74 winter (about 22 inches); Putah Creek was in flood much of the winter and through mid April, and although *acmon* was seen near Davis as early as 19 March it had not appeared at Putah a month later.

At all elevations in California the *acmon* produced by overwintered larvae are of the spring phenotype, "*cottlei*" Grinnell. When the first flight dates for *acmon* at Putah or elsewhere on the Valley floor are as late as mid-May, the first individuals taken are of the summer phenotype corresponding to the second generation emerging at other, nearby localities where a March–April flight had been observed. The control of this phenotypic switch has never been studied in a controlled laboratory experiment, but its seasonality argues against May or June butterflies on the Valley floor being produced by overwintered larvae.

At Davis *P. acmon* breeds extensively on *Polygonum aviculare* L. (Polygonaceae), a common vacant-lot weed which has a succession of generations throughout the year. The vacant lots in which plant and butterfly occur are plowed under one or more times each year, and I have been able to study the rate of recolonization by *acmon*. These studies, still in progress, demonstrate that this is a very vagile butterfly with extraordinary colonizing ability. It should not be surprising that its populations at Putah Creek are periodically wiped out by catastrophic flooding and replaced by colonizing butterflies from elsewhere. At least in the Sacramento Valley, it is very unlikely that any population of *P. acmon* can persist long enough to undergo much genetic adaptation to a local microclimate (or hostplant).

Goodpasture is correct in stating that *P. acmon* flies earlier near Monticello Dam than on the Valley floor; it begins emerging there in late February apparently every year, two–four weeks ahead of Davis. However, it is far from unique in this regard; so do *Lycaena helloides* Boisduval, *Strymon melinus* Hubner, *Atlides halesus* Cramer (all Lycaenidae), *Pieris rapae* L., *Colias eurytheme* Boisduval (Pieridae), *Precis coenia* Hubner and *Phyciodes mylitta* Edwards (Nymphalidae), all common multi-voltine species which overwinter in the larva or pupa, as well as the hibernating nymphalids. Rather than postulating that all these vagile (potentially panmictic) species have convergently evolved phenological ecotypes in the Valley and adjacent canyons, it is more parsimonious to look for environmental differences which would call forth an earlier emergence in the canyons given identical genetic "instructions." Such differences are not hard to find. The canyons have higher minimum temperatures, fewer days and hours of fog and low cloudiness, and much less wind than the Valley floor in winter and early spring. The discrepancy between first flight dates of weedy butterflies in the Valley and the Vacas is mirrored, incidentally, in the flowering dates of weedy plants.

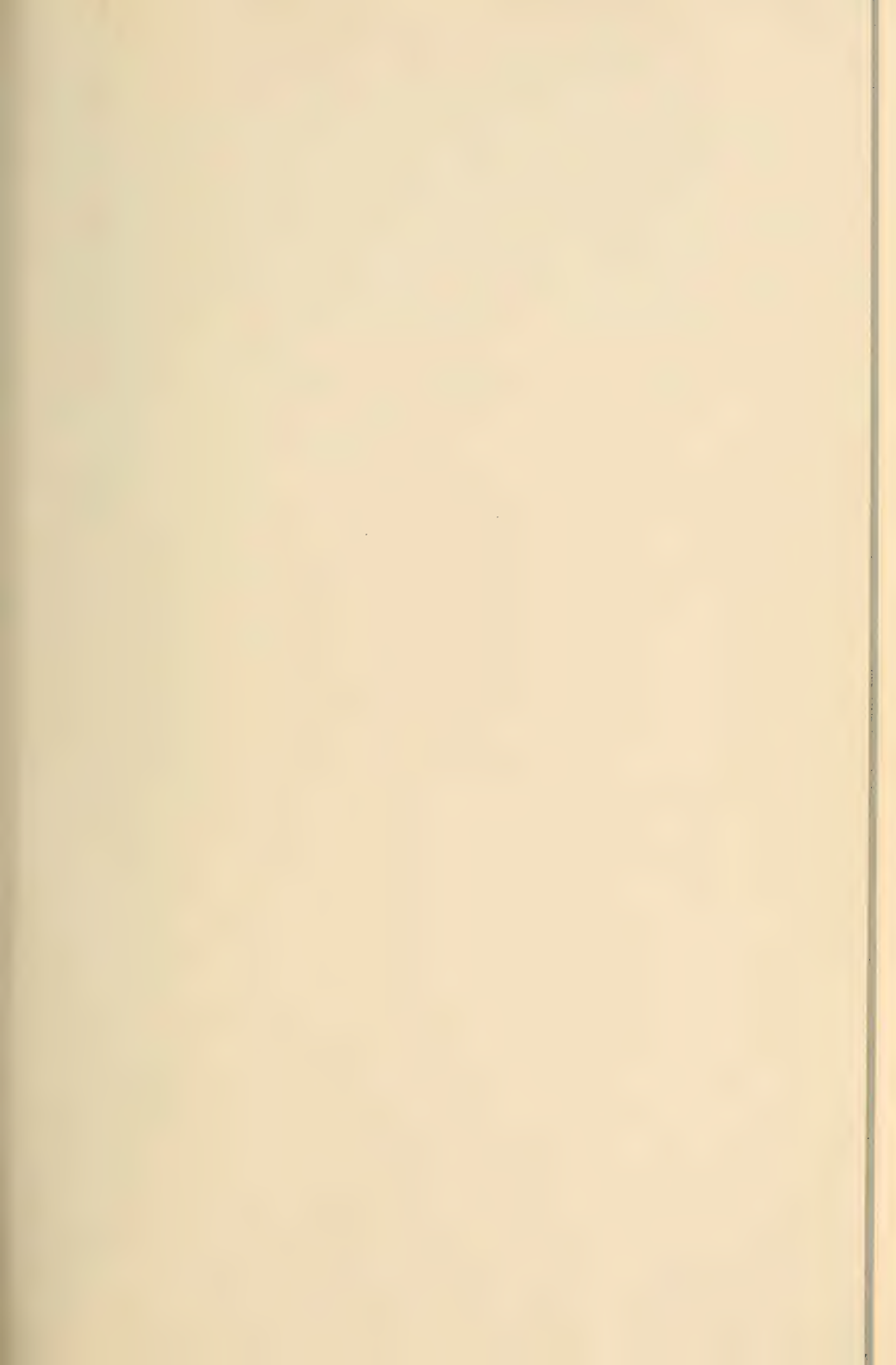
ARTHUR M. SHAPIRO, *Department of Zoology, University of California, Davis, California 95616.*

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JOURNAL

of the

LEPIDOPTERISTS' SOCIETY

Published quarterly by THE LEPIDOPTERISTS' SOCIETY

Publié par LA SOCIÉTÉ DES LÉPIDOPTÉRISTES

Herausgegeben von DER GESELLSCHAFT DER LEPIDOPTEROLOGEN

Publicado por LA SOCIEDAD DE LOS LEPIDOPTERISTAS



15 April 1975

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A SYNONYMIC LIST OF THE NEARCTIC RHOPALOCERA

by CYRIL F. DOS PASSOS

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JOURNAL OF THE LEPIDOPTERISTS' SOCIETY

Volume 29

1975

Number 1

THE LIFE CYCLE OF *ORNITHOPTERA PARADISEA* (PAPILIONIDAE)

H. BORCH

Maprik, Territory of Papua and New-Guinea

AND

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During the years 1972 and 1973, the senior author collected data on the behaviour and the life history of *Ornithoptera paradisea* Staudinger, a butterfly that is probably the most elegant, exquisite and beautiful in the world and that fully deserves its name (Fig. 12).

This species occurs through a wide area in northern New-Guinea, but it is local and its numbers are rather limited. The habitat is the primary forest on hilly or mountainous areas, ranging from 500 m to 1000 m in altitude. Specimens are occasionally found higher: a ♂ was once observed over 2000 m.

Adults are rarely seen in the open. Males usually fly high around forest trees. Females usually fly under the canopy in search of the foodplant.

The male emits a delightful smell from the beautiful fringe of pure white hairs along the last anal vein. This fact is unique among the *Ornithoptera*. Unfortunately, the smell disappears when the specimens dry and does not reappear when they are relaxed.

The ova are often parasited by tiny Hymenoptera, probably Chalcididae, and the larvae by some species of Braconidae. Predators, such as lizards, ants and frogs, also take a heavy toll of larvae and pupae. Certain weather conditions are a hazard to immatures, especially during the northwest monsoon season. Strong winds and driving rain may account for approximately 30% of the fatalities in the larval stage.

The foodplant is an undetermined species of large-leaved *Aristolochia*, with bright orange, elongated fruits (Fig. 1). It grows only in the heavy rain-forest where it climbs high into the forest canopy. It never occurs in the open secondary bush.

A description of the immature stages has already been given by Jordan (1908). Because it is short and rudimentary (*Ein verlässliche detaillierte Beschreibung aller Entwicklungsstadien fehlt noch.*), we are happy to fill the gap.

Egg (Fig. 2). A single *ovum* is laid on the ventral surface of a leaf of the host plant and sometimes, but rarely, on a nearby object. The egg is large, 4 mm in diameter, light orange and flattened at base. The orange colour fades as the egg matures. Incubation period 10–12 days.

First instar larva (Fig. 3). 8 mm in length on emergence. Ground colour very dark, wine red. All segments with long tubercles, fleshy on basal $\frac{1}{3}$ and stiff on apical $\frac{2}{3}$, bearing long bristles. Head capsule and pronotal shield black. Dorsal and latero-dorsal mesonotal tubercles with their basal $\frac{2}{3}$ red or pink red, this colour extending basally onto notum; but its center is dark. Occasionally two dark red spots at the inner base of the dorso-lateral tubercles on the metanotum. Abdominal segments 1, 2, 3 dark. Saddle-mark pink red, the colour reaching the basal $\frac{2}{3}$ of tubercles, but interrupted medially by dark colour. Segments 5, 6 dark. Segments 7, 8, 9 dark pink, the colour reaching the basal half of tubercles, with or without a narrow median dark line. Osmaterium orange, with red slit.

Second instar (Fig. 4). Basic colour velvety black. All tubercles longer in proportion and without bristles. Latero-dorsal pronotal, dorsal and latero-dorsal mesonotal, and metanotal tubercles red, with long black tips. Dorsal tubercles on abdominal segment 1 occasionally with a dark red annulus. Dorsal tubercles on segment 4 thicker and longer than others, red, with short black tips, but the red colour does not extend to the segment itself. Dorsal tubercles of segments 7, 8, 9 red with black tips. A dark red annulus occasionally present on latero-dorsal tubercles of segments 7, 8.

Third instar (Figs. 5–6). Basic colour black. All tubercles smaller in size than in second instar. Membrane behind head capsule red. All thoracic and abdominal dorsal tubercles almost entirely red, with black tips. Those of segment 4 very thick at base and with a bit of cream colour basally. Lateral tubercles of pronotum and dorso-lateral and lateral tubercles of meso- and metanotum red with black tips. Lateral tubercles of 1st abdominal segment black, those of other segments partially red.

4th and 5th instars (Figs. 7–9). Basic colour black. Membrane behind head capsule black. Tubercles of thorax and three first abdominal segments smaller than those in third instar. All dorsal tubercles partially red except those on abdominal segment 4 that have a bit of cream colour basally. Tubercles of abdominal segments 1, 2, 3 have only a hint of red. Maximum length 100 mm. Duration of larval period 36–40 days.

Pupa (Figs. 10–11). Dorsally more slender than in *poseidon* and covered with wax-like coating. Colour and markings showing wide individual variations. Basic colour brown, darker laterally on abdominal segments. Wing-cases brown with center dull yellow, venation dark. Saddle-mark bright yellow and orange below wing-cases. Tegulae orange. Abdominal segments orange yellow dorsally. Two short and sharp black-tipped processes on abdominal segments 3–6. Average length 60 mm. Average duration of pupation 37 days.



Figs. 1, 2. *Ornithoptera paradisea* Staudinger and its foodplant. 1, Foodplant, *Aristolochia* sp.; 2 ovum. (Printed in Canada.)



Figs. 3, 4. *Omithoptera paradisea* Staudinger. 3, First instar larva; 4, second instar larva. (Printed in Canada.)



Figs. 5, 6. *Ornithoptera paradisea* Staudinger, third instar larvae. 5, Dorsal view; 6, left lateral view. (Printed in Canada.)



Figs. 7, 8. *Ornithoptera paradisea* Staudinger. 7, Fourth instar larva, dorsal view; 8, fifth instar larva, dorsal view. (Printed in Canada.)



Figs. 9, 10. *Ornithoptera paradisea* Staudinger. 9, Fifth instar larva, dorsal view; 10, pupa, left lateral view.
(Printed in Canada.)



Figs. 11, 12. *Ornithoptera paradisea* Staudinger. 11, Pupa, dorsal view; 12, newly emerged male (Printed in Canada.)

LITERATURE CITED¹

JORDAN, K. 1908. Indo-australian butterflies. Page 17 in A. Seitz, The Macrolepidoptera of the World, 9.

¹This article was already in press when we learned that *inagines* was the population we studied and that it had recently been described as a new subspecies *borchi* Haugum and Low (Entomol. Rec. J. Var., 1974, Vol. 86 (4): 109-114). We do not recognize the validity of this taxon and consider the population we worked on as a mere local race of the typical subspecies that will better remain unnamed.

NOTES ON COLLECTING PAPAPEMA DUOVATA (NOCTUIDAE)

Between 16 and 20 September 1974, while vacationing in West Yarmouth, Barnstable Co., Massachusetts, I collected 12 specimens, all males, of *Papaipema duovata* Bird (Nocturidae). This species is generally considered to be very rare and local, in part because of its restriction to Seaside Goldenrod (*Solidago sempervirens* L.) as a larval foodplant. As the present specimens were taken in an unexpected manner, a brief account of their capture may be of some interest.

My cottage was located on an inlet, some quarter-mile from the ocean, and was surrounded by blooming patches of Seaside Goldenrod. Each evening a 15-watt fluorescent blacklight was operated on the east side of the cottage, but no specimens of *P. duovata* were ever found at this source. Rather, the 12 specimens were taken in the vicinity of a small, 40-watt incandescent bulb which was located near the front door on the south side of the cottage. It also seems noteworthy that none of the moths came to rest within three feet of the bulb itself, and that most were found resting at distances of from 6-12 feet from the bulb.

These two particulars, i.e. that the moths came to a relatively weak incandescent light, and that they then rested some considerable distance from the source, suggest that the species might have been missed, had only the usual bulbs (blacklight, mercury vapor) and traps (funnel) of the modern collector been used. These observations raise the possibility that certain species may be considered rare only because they are rarely taken by the collecting methods currently in vogue. One should be particularly aware of this possibility when a species that is apparently rare at the present time was considered more common by earlier collectors. Perhaps we have lost more than the romance of collecting with candles and lanterns—some moths might better be drawn to a flame!

It also seems worth noting that all 12 specimens of *P. duovata* came to the bulb during a one-hour period from shortly after 2200 to shortly after 2300 (EST).

THEODORE D. SARGENT, *Department of Zoology, University of Massachusetts, Amherst, Massachusetts 01002.*

SPICEBUSH, *LINDERA BENZOIN*, A LITTLE KNOWN
FOODPLANT OF *PAPILIO GLAUCUS* (PAPILIONIDAE)

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Papilio glaucus L., the eastern tiger swallowtail, is one of the most polyphagous of all Papilionidae, yet documented records of it utilizing lauraceous foodplants are rare. Teitz (1954, 1972) is the only author who reports *Lindera benzoin* (L.), but we have been unable to locate any such original record from the references he listed. *Sassafras albidum* (Nutt.) also is recorded by Edwards (1884), French (1885), Scudder (1889) and Teitz (1954, 1972). These authors have apparently cited either Stauffer (1862) or personal communication of John Akhurst. The larval description ("... the larva of *turnus* (which was taken from *Sassafras*) was pea-green above with a yellow edging, beneath purplish-brown.") suggests that Stauffer's record is based on a mistaken *P. troilus* larva. Akhurst records a *P. glaucus* female ovipositing on *Sassafras* branches while confined in a box.

Five freshly hatched first instar *Papilio glaucus* larvae were discovered on leaves of spicebush, *Lindera benzoin* of the Lauraceae, on Snyder Hill near Thomas Road, Town of Caroline, Tompkins County, New York. This same stand of spicebush yielded *P. troilus* L. larvae the previous year, although none were found there in 1973. In addition to the *P. glaucus* larvae found on June 25, 1973, another fertile egg was discovered on July 11. For comparisons with growth rates on other foodplants (Scriber, in prep.), field growth rates of larvae were observed on spicebush until they reached the late stages of the final instar. At this point they were taken into the laboratory, and weighed.

In our bioclimatic control chambers, we have successfully reared *P. glaucus* from the Ithaca, New York area from the first instar through pupation on *L. benzoin* and *S. albidum*. Also, first instar larvae obtained from eggs laid on *Prunus serotina* Ehrh. were placed on spicebush and sassafras in the field, where they successfully completed development. When placed in a large walk-in screened cage (16' × 20' × 15') stocked with various transplanted deciduous saplings, *P. glaucus* females oviposited on *Lindera benzoin* and *Sassafras albidum*, as well as on its other more widely recognized foodplants, such as *Liriodendron tulipifera* L. and *Magnolia virginiana* L. (Magnoliaceae), *Prunus serotina* (Rosaceae) and *Fraxinus americana* L. (Oleaceae). Other plant species present in

the cage, but not utilized by *P. glaucus* for oviposition, included *Pastinaca sativa* L. (Umbelliferae), *Dictamnus Fraxinella* Pers. (Rutaceae), *Rhamnus cathartica* L. (Rhamnaceae) and *Syringa vulgaris* L. (Oleaceae).

There are presently a minimum of 26 species of Papilionidae known to utilize the Lauraceae as larval foodplants, including the genera *Eurytides*, *Protographium*, *Graphium*, and *Papilio* (Scriber, 1973). In the New World the two primary sections of *Papilio* that feed on the Lauraceae are (1) the Neotropical *P. homerus* and *P. scamander* groups which appear to be polyphagous and (2) the North American *P. glaucus* and *P. troilus* groups. Both groups have similar green larvae, bearing large mimetic thoracic eyespots, whereas larvae of the Old World Lauraceae-feeding *P. clythia* and *P. agestor* groups differ greatly in appearance (Munroe, 1960).

The precise phylogeographical and allelochemical (Whittaker and Feeny, 1971) role that the Lauraceae have played in the evolution of the Papilionidae is undoubtedly important, but not entirely certain. Forbes (1932, 1958) and Munroe (1948) suggested that the Graphiini were the most primitive of the Papilionidae and originally fed on Lauraceae with *Papilio* evolving directly from them in turn. Since the Lauraceae, along with the Annonaceae, Magnoliaceae and the Aristolochiaceae, are generally considered to be among the most primitive of all flowering plants (Cronquist, 1968; Takhtajan, 1969), the suggestion was made that the Papilionidae originated in the late Jurassic (Forbes, 1932) and that it was generalized (polyphagous) species which were the ancestral types (Forbes, 1932, 1958). This date for the origin of the Papilionidae does not conflict with Smart and Hughes (1973) or Gressitt (1974).

Because the phylogeny of the Graphiini is more clearly understood than most other groups of butterflies, Munroe (1948) felt that the zoogeographical distribution of the tribe would be of particular significance and proposed the following: (1) *Eurytides*, which is represented by several species in the New World reportedly feeding on Lauraceae (D'almeida, 1966; Lima, 1968) and by a somewhat divergent one in Australia, is the ancestral group of the more specialized *Graphium*. Other primitive groups of Graphiini appear to have relict distributions in Asia, which with the East Indies is their presumed place of origin. (2) The graphiines may have attained a global distribution during the Cretaceous or late Jurassic via the spread to all continents of the more primitive *Eurytides*. (3) During a later cooler period, perhaps the Laramide, when the higher graphiines such as *Graphium* either had not yet evolved, or at least not reached the New World along with more

primitive forms, the *Papilio glaucus* and *P. troilus* groups (the genus being derived from the most primitive of the higher graphiines) were presumably able to spread into the more temperate North American continent. Fossil records supply evidence that plants very similar to the present-day *Sassafras* and *Liriodendron* had appeared in the middle latitudes by the early Cretaceous (Axelrod, 1966), further supporting Munroe's theory. Since that time however, the *P. glaucus* group has had a history which is purely North American (Munroe, 1963).

If it is presumed that the *P. glaucus* and *P. troilus* groups are primitive, as Forbes (1932, 1958) and Munroe (1948) suggest on the basis of an extra row of crochets on the prolegs, raised eyespots corresponding to the 3rd thoracic pair of spines in *Graphium*, the ancestral lauraceous foodplant, etc., then the South American *P. homerus*, *P. scamander* and *P. zagreus* complex in which the lauraceous foodplant is retained might be derived directly (Munroe, 1948).

A major problem in understanding the phylogeny of the Papilionini is that there are a variety of superficial changes in pattern and structure. Furthermore there appears to have been an overwhelming switch of the "typical" *Papilio* of Forbes (1932) to the Rutaceae on a world wide basis. It was thought (Forbes, 1932, 1958) that the Rutaceae were secondary foods for the ancestral Papilionini, much as the Umbelliferae, Compositae, Rosaceae, and Piperaceae are today. Forbes' suggestion (1932) that the switch to Rutaceae might be related to the "similarity of flavor" has proven to be a fruitful starting point for several others who have investigated co-evolutionary relationships of the Papilionidae and their hostplants of which several secondary chemicals such as alkaloids, essential oils and glycosides are shared (Dethier, 1941, 1970; Ehrlich and Raven, 1965; Feeny, 1975; Fraenkel, 1969; Scriber, 1972; and Slansky, 1972).

Munroe and Ehrlich (1960) apparently resolved the alternative hypotheses presented in Munroe (1960) concerning the relationship of the red-tuberculate *Aristolochia*-feeding larva to the green, sometimes brown, sometimes spinose, *Lauraceae*-feeding or *Rutaceae*-feeding larva. The red-tuberculate larva must be primitive, meaning that the primitive Graphiini must have had red-tuberculate larvae and fed upon *Aristolochia*, not on Lauraceae as was thought earlier (Forbes, 1932, 1958; Munroe, 1948, 1960). Nevertheless the importance of the Lauraceae to the Graphiini and the Papilionini should not be overlooked.

Although the polyphagous *P. glaucus* feeds successfully on Lauraceae, it would appear that for the *glaucus*-group as a whole (Brower, 1958), the preference for lauraceous foodplants is minimal and therefore has

remained undetected. This is especially noticeable when the *glaucus*-group is compared to the closely related *troilus*-group. Our initial observations are interesting perhaps in a qualitative sense because they emphasize the possibility of a co-evolutionary interaction between the two butterfly groups and one of the earliest of all angiosperm families. However more information is needed to make more meaningful quantitative assessments of these particular relationships.

ACKNOWLEDGMENTS

Financial support was provided by N. S. F. Grant No. GB 33398 (P. P. Feeny) for the walk-in ovipositional cage, which was built and stocked with the assistance of R. Haskins and A. Miller.

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GENETIC STABILITY OF POPULATIONS OF
PHYCIODES THAROS (NYMPHALIDAE: MELITAEINAE)

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The elucidation of patterns of genetic variation between geographically separate populations is central to the study of evolution. Knowledge of such patterns contributes to an understanding of population structure and of the action of natural selection. Diverse selection pressures acting at different localities within a species' range may lead to local adaptation through genetic differentiation, and, in some instances, to speciation.

Electrophoretic separation of allelic forms of enzymes, or allozymes, has proven to be a useful tool for investigating genetic variability (Harris, 1966; Lewontin & Hubby, 1966; Selander & Johnson, 1973; Selander & Kaufman, 1973). Allozymes represent discrete phenotypic variation that can be statistically compared to a particular genetic model and can thereby be used for estimating gene frequencies at a number of different loci in natural populations. The frequencies thus estimated can be compared between populations, giving an indication of genetic differentiation at a number of enzyme-synthesizing loci. It is the purpose of the present study to assess genetic differences between populations of the butterfly *Phyciodes tharos* (Drury) by means of starch-gel electrophoresis of isozymes. The determination of such patterns not only provides information concerning the amount of population differentiation in this widely distributed species, but also may aid in understanding the effects of natural selection on protein-synthesizing loci in various populations.

While some authors contend that allozyme variability is selectively neutral (Kimura, 1968; King & Jukes, 1969; Kimura & Ohta, 1971), the existence of patterns such as clines along environmental gradients or genetic constancy over a wide geographic range seems to provide strong evidence for the adaptive nature of this variation.

P. tharos is distributed widely over most of North America. Although three subspecies have been named (dos Passos, 1969), the nominate *P. tharos tharos* (Drury) occupies all of the species' range in the United States east of the Rocky Mountains and shows very little geographic variation in phenotypic appearance (Klots, 1951). Despite this uniformity, the species occurs in a number of different habitat types. This, together with its wide geographic range, allows sampling from populations which can reasonably be assumed to be subject to very different

environmental selection pressures and in which any genetic differentiation likely to arise from such differences may be accentuated.

METHODS

Samples of *P. tharos* were obtained primarily from three field collections. One sample of 105 male butterflies was taken in open pine woods 6 km N of Silsbee, Hardin Co., Texas, on March 22, 1973. Two other collections were made in the vicinity of Ithaca, New York, on September 13, 1973. One of these (Brooktondale, N.Y.) included 55 individuals (38 males and 17 females) from the Wilseyville Valley 13.5 km SE of Ithaca, Tompkins Co., New York, near the village of Brooktondale. This collection was made from a hayfield which had been mowed earlier in the summer. The third collection (Lansing, N.Y.) consisted of 73 individuals (56 males and 17 females) from fields near the Tompkins Co. airport 5.5 km NE of Ithaca. The habitat in this locality consisted of small marshy areas connected by slowly flowing rivulets which run through the fields. The two areas near Ithaca are separated by a linear distance of 16.5 km. In addition to these three main samples, a small sample of eight individuals (4 males and 4 females) was collected in the vicinity of Huntsville, Madison Co., Alabama, on October 3-4, 1973.

Extraction of soluble proteins was accomplished by homogenizing the insects, after removal of legs and wings, in 0.1 ml of a pH 7.0 buffer of 0.1 M tris, 0.001 M EDTA and 5×10^{-5} M NADP. Homogenates were drawn into capillary tubes, centrifuged at 10,000 rpm and stored at -80°C . Techniques of horizontal starch-gel electrophoresis were similar to those of Selander et al. (1971). After electrophoretic separation, the samples were stained for each of five enzymes representing five genetic loci. These were α -glycerophosphate dehydrogenase (α -GPD), phosphoglucomutase (PGM), phosphohexose isomerase (PHI), malate dehydrogenase (MDH) and glutamate-oxaloacetate transaminase (GOT). The first three enzymes (α -GPD, PGM and PHI) are involved in the glycolytic pathway; MDH is a Krebs's cycle enzyme; and GOT represents an important link between the Krebs's cycle and amino acid synthesis. The electrophoretic patterns observed for each of these enzyme-synthesizing loci could clearly be assigned to a genetic model. While PGM is apparently a structural monomer for which heterozygotes give a characteristic two-banded pattern, the remaining four enzymes (α -GPD, PHI, MDH and GOT) appear to be structurally dimeric; the heterozygotes show three bands on electrophoresis (Fig. 1). Gene frequencies were estimated directly from the observed zygotic frequencies.

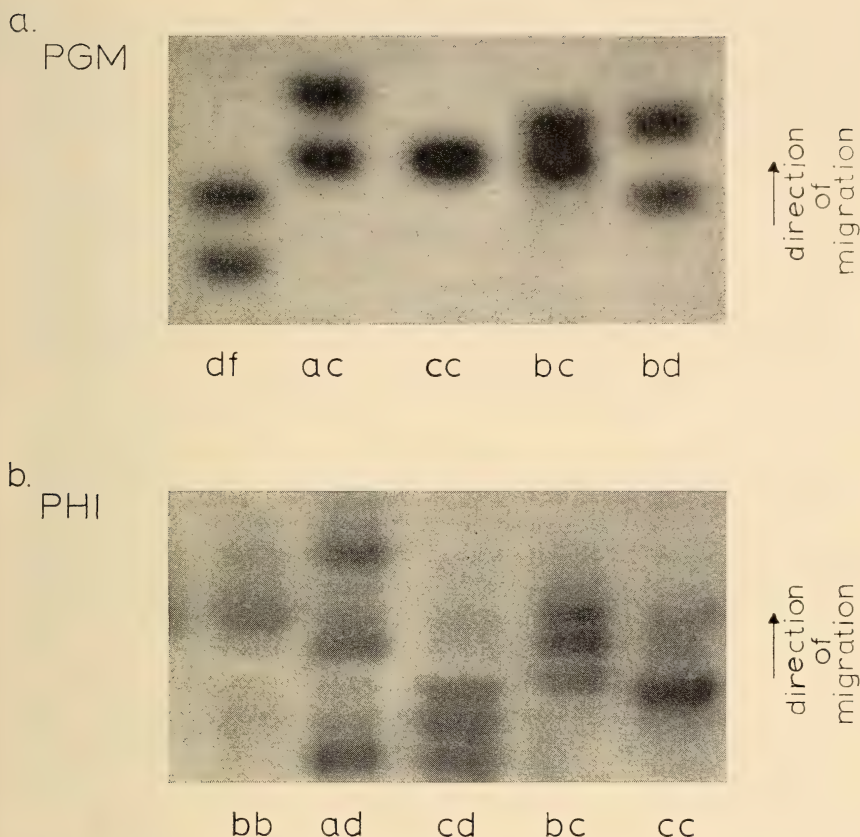


Fig. 1. Typical starch-gels after electrophoresis of *P. tharos* homogenate and staining for PGM, a monomeric enzyme (Fig. 1a) and PHI, a dimeric one (Fig. 1b). Each gel represents five individuals, and presumed genotypes are given below the gels.

RESULTS

Estimated gene frequencies and sample sizes for the five loci examined in *P. tharos* are shown in Table 1. These frequencies were used to calculate expected zygotic frequencies under conditions of Hardy-Weinberg equilibrium using the exact formula of Levene (1949). Deviations of the observed from the expected zygotic frequencies were tested for statistical significance using the G-test for goodness of fit, since for small sample sizes the G-statistic more closely approaches a true Chi-square distribution than does the more traditional χ^2 statistic (Sokal & Rohlf, 1969). Where appropriate, rare alleles were lumped with more common ones for the purpose of statistical analysis. Values for G, degrees of

TABLE 1. Gene frequencies for alleles at five polymorphic loci in *Phyciodes tharos* from four localities, 1973. Alleles are designated alphabetically in order of decreasing anodal mobility. Also included in the table are values for G with appropriate degrees of freedom after lumping G(df) and probabilities (P) associated with the deviations of the observed zygotic frequencies from Hardy-Weinberg expectations.

	Sample size	a	b	c	d	e	f	G(df)	P
PHI									
Silsbee, Texas	87	.03	.30	.49	.18			7.6241(3)	> .05
Lansing, New York	26	.02	.40	.42	.15			2.2002(1)	> .10
Brooktondale, New York	25	.02	.20	.56	.22			5.6162(1)	< .05*
Huntsville, Alabama	8	.06	.38	.31	.25			—	—
GOT									
Silsbee, Texas	87		.99	.01				.0641(1)	> .50
Lansing, New York	59	.01	.97	.02				.2146(1)	> .50
Brooktondale, New York	25	.04	.92	.02	.02			2.9390(1)	> .05
Huntsville, Alabama	7		.86	.14				—	—
α -GPD									
Silsbee, Texas	97		.99	.01				.0641(1)	> .50
Lansing, New York	66	.02	.98					.1918(1)	> .50
Brooktondale, New York	52		1.00					—	—
Huntsville, Alabama	8		.88	.12				—	—
MDH									
Silsbee, Texas	99	.01	.90	.09				.0466(1)	> .50
Lansing, New York	69	.01	.83	.16				.0403(1)	> .50
Brooktondale, New York	55	.02	.86	.12				1.2236(1)	> .10
Huntsville, Alabama	8	.06	.81	.06	.06			—	—
PGM									
Silsbee, Texas	93	.19	.23	.30	.20	.08		13.8875(3)	< .01*
Lansing, New York	69	.09	.20	.36	.33	.02		4.3036(3)	> .10
Brooktondale, New York	54	.08	.21	.34	.31	.03	.03	.4084(3)	> .90
Huntsville, Alabama	8		.25	.38	.38			—	—

* Deviation from Hardy-Weinberg expectation significant at .05 level.

freedom and appropriate probabilities for the observed deviations are also shown in Table 1. Deviations from Hardy-Weinberg equilibrium are statistically insignificant in all but two cases. The general agreement with Hardy-Weinberg expectations exhibited for the other enzyme loci provides evidence for the correctness of the assumed genetic model in each case. The deviations from expected values in the case of PGM from Silsbee, Texas, and that of PHI from Brooktondale, New York, are most probably due to scoring errors, since each of these enzymes is represented by three common allozymes with quite similar mobilities. Alternate interpretations for deviations from Hardy-Weinberg expecta-

tion such as selection or population subdivision seem less likely and are inconsistent with the rest of the data.

The most striking aspect of these results is the geographic constancy of the gene frequencies. As can be seen in Table 1, for the loci examined in this study one finds, with few exceptions, that the rank order of gene frequencies remains the same from population to population; or, that is, that alleles which are the most common in one population are the most common in other populations. In the cases where this is not true, PHI and PGM, variations from this pattern can be readily explained by noting that, in all populations, these loci are represented by 2 or 3 common alleles occurring at similar frequencies, so that alteration of the rank order is produced by small variations of the gene frequencies.

DISCUSSION

The results of the present study indicate that there is little geographic differentiation in allozyme frequencies among populations of *P. tharos*. These results are similar to those obtained by a number of authors working with various species of *Drosophila* (O'Brien & MacIntyre, 1969; Prakash, Lewontin & Hubby, 1969; Rockwood-Sluss, Johnston & Heed, 1969; Ayala, Powell & Dobzhansky, 1971; Ayala et al., 1972) and for the butterfly *Hemiargus isola* (Burns & Johnson, 1971). Such patterns of geographic constancy of gene frequencies are clearly inconsistent with an hypothesis proposing selective neutrality of alleles. Under selective neutrality one would expect to find a random pattern of predominance or fixation of selectively equivalent alleles among geographically separate populations. The existence of a clear pattern, albeit one of clinal variation or geographic constancy, is direct evidence for the action of selection. Kimura & Ohta (1971) argue that, assuming certain conditions concerning effective population sizes and mutation rates, a mobile and widely distributed species may approach panmixis over large portions of its range, thus preventing genetic differentiation even among selectively neutral alleles. Although ecological data concerning population densities and migration rates which would allow an assessment of the reasonableness of this approach are not available for *Phyciodes tharos*, other evidence will be introduced later in this discussion which indicates that this species is far from panmictic over the portion of its range we have examined here.

If the observed genetic variability within populations of *P. tharos* is maintained by some form of balancing selection, the patterns observed in the present study should allow some inferences concerning the nature of this selection. In particular, what kind of selection pressures could

lead to a pattern of geographic constancy such as that observed for *P. tharos*? It is possible that, in spite of the large distances involved and the obvious differences in climate between New York, Texas, and Alabama, the collections of *P. tharos* used for this study came from similar microhabitats and that the enzyme loci examined here are subject to similar selection pressures in all populations represented. Although these collections were made in different vegetation types including, for example, hayfields in New York and open pine woods in Texas, it is impossible, with our present information, to exclude the possibility that the convergence of gene frequencies for the various localities is due to factors of the external environment not evident to us, but which remain constant over much of the species' range.

An alternative hypothesis is that the loci examined have been selected to operate in a certain internal physiological and genetic milieu and that the observed pattern of geographic constancy is the result of coadaptation of loci within the species' genome. Prakash, Lewonton & Hubby (1969) proposed such an hypothesis as an explanation for the pattern of genetic constancy observed for populations of *Drosophila pseudoobscura*. Such a pattern need not obtain over all of a species' range nor over the entire species' genome. In a species where gene flow between populations is a rare event, constellations of coadapted alleles could reach frequencies representing independent optima in different populations. However, loci which are thus selected for as integral parts of coadapted gene complexes would not necessarily be affected by external environmental differences. Thus any detectable pattern of geographic variation would not be interpretable in a climatic or microenvironmental context. Moreover, while such internally coadapted genes may be free from variation with climate or habitat, other parts of the genome which interact more directly with the external environment may not be. These genes would be the ones which might show differences that parallel environmental gradients.

This model can explain the apparent discrepancy between our results and those of Oliver (1972). His study of geographic differentiation in four species of Lepidoptera, including *Phyciodes tharos*, entailed comparisons of phenotypic differences in appearance, physiology, and genetic incompatibility between populations from widely separated parts of the species' ranges. He found that variation in phenotypic appearance, physiology and degree of interpopulation compatibility varied discordantly. Clearly, various aspects of population differentiation respond independently to environmental gradients or biogeographic factors; some characteristics may vary geographically while others remain constant.

Epistatic interactions between loci coding for the former type of characteristic and those coding for the latter type would lead to integration of these two parts of the genome within populations, thereby allowing local adaptation. An hypothetical example might help to clarify this point. An allele for a particular enzyme may have identical physiological effects in an individual of a given species regardless of geographic location within the species' range and may, therefore, occur in identical frequencies in all populations, while an allele at another locus coding for the production of this enzyme during the life history of the individual may vary geographically in frequency in a manner closely paralleling climatic differences over the species' range. Crosses between geographically separate populations would demonstrate incompatibility in spite of genic similarity at many loci. In a species such as *P. tharos*, an inhabitant of ephemeral and unstable habitats, selection might well favor an integrated, coadapted genome with high average fitness in a wide range of environments. Local adaptation, then, would involve developmental rates, voltinism and other traits which act as "fine tuning" of the "all-purpose" genotype. Oliver's findings of geographic variation in developmental rates, voltinism and other characters under polygenic control are, therefore, not at odds with our own.

Furthermore, Oliver's results showing geographic differentiation for at least some loci indicate that *P. tharos* is by no means effectively panmictic over large portions of its range. This suggests, as was asserted earlier in this discussion, that the pronounced interpopulation similarities in gene frequencies which we have reported for *P. tharos* are due to selection and not to gene flow.

SUMMARY

Electrophoresis on starch gels was used to separate allelic forms of five enzymes (α -GPD, PGM, PHI, MDH and GOT) in the butterfly *Phyciodes tharos* from 4 localities, 2 in southcentral New York, 1 in Texas and 1 in Alabama. A comparison of gene frequencies between these localities indicated considerable stability—for each enzyme, the various alleles occurred in similar frequencies in all populations. This lack of differentiation suggests that the polymorphisms concerned are maintained by some form of selection and not by random drift of selectively neutral alleles. Since the collections were made over a wide geographic range and in a number of different habitat types, the results of this study suggest that the selective forces involved are probably associated with the maintenance of coadapted gene complexes rather than direct interaction with the environment. It is suggested, however, that local adapta-

tion can still be achieved by the epistatic interaction of these coadapted gene complexes with control genes and modifiers which may be strongly selected by the local environment.

ACKNOWLEDGMENTS

This research was supported by NSF Grant No. GB 26224 and NIH Grant No. GM 18329 awarded to P. F. Brussard.

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A SECOND EXTANT COLONY OF *PIERIS VIRGINIENSIS* IN ONTARIO (PIERIDAE)

The relatively recent acceptance of *Pieris virginiensis* Edwards as a species (distinct from *Pieris oleracea*) leads to considerable difficulty in determining its range from existing collections. Local and colonial in its distribution and at the northern limit of its range in Ontario, where it inhabited only certain selected rich hardwoods of the many where *Dentaria* spp. grows, it had been considered extinct in the province. Its previously known stations, cited by Riotte (1967, *Proc. Entomol. Soc. Ontario* 98: 27–29), at Hamilton, London and Etobicoke, have all succumbed to urban development. However, in 1965 it was rediscovered by Holmes in the Halton County Forest Riotte (1967), and since then this extensive woods has remained the only known Ontario locality despite extensive field work throughout the province.

Unusually interesting, then, was the reported specimen by Warren (1963, *Entomol. Ts.* 84: 1–4), from “Grand La Cloche Island” (presumably Great Cloche Island, Manitoulin District) in the British Museum, with the implication of a possible surviving colony in that area.

Now, despite examinations of many stations in southern Ontario for the relatively common *Dentaria*, until 1973 *Pieris virginiensis* was found only in one. In the heavily glaciated limestone of Manitoulin District even suitable habitat for *Dentaria* is unusual, namely accumulations of rich soil sufficiently deep to support hardwood forest. To my knowledge, such habitat is absent on Great Cloche Island. Furthermore, even amongst these relatively infrequent hardwood forests, the occurrence of *Dentaria* is infrequent. Soper (1973, pers. comm.), was able to find only four stations, all of *Dentaria diphylla*, in the whole district, only one of which was on Manitoulin Island itself. A survey of Manitoulin Island by the author and some members of the Toronto Entomological Society failed to reveal any additional *Dentaria* in the many possible suitable sites examined until, in May 1972, the author was directed to a badly cut-over maple woods in the central part of the island where moderate numbers of both *Dentaria diphylla* and *laciniata* were in flower. Despite several visits no Pieridae were observed there in 1972. However, on 20 May 1973, four female specimens were taken flying weakly amongst the clearings and along paths in the woods. Identification has been confirmed by J. C. E. Riotte, and two specimens deposited in the collection of the Department of Entomology and Invertebrate Zoology, Royal Ontario Museum.

This collection completes a link in the chain of occurrences of this species between Michigan in the west and southern Ontario and New York to the southeast, raising the hope that still further populations may yet be discovered. *Pieris virginiensis*, because of its habits and local habitat, which is especially vulnerable to urban development and cutting for firewood, must be regarded as an endangered species in Ontario.

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MOVEMENTS OF *EUCHLOE AUSONIDES* (PIERIDAE)

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Until recently, most butterflies have been thought to be quite sedentary, except for a few migratory species. This paper and that of Brussard & Ehrlich (1970) report quite large flights of non-migratory species, showing that, perhaps like most taxa, butterfly species form a continuum from those having sedentary habits to those which are migratory. This paper is part of a broader study on movements of diurnal Lepidoptera (Hesperioidea and Papilionoidea) emphasizing the relationship between adult behavior, especially mate-locating behavior, and movements. Previous papers showed that mate-locating behavior, mating, movements, feeding, oviposition, and basking affected each other and were adapted to local topographic and climatic conditions (Scott, 1973a, b). Local adaptation was found to promote convergence of magnitude of movements and behavior between two sympatric species (Scott, 1973c). The present paper deals with adult movements of *Euchloe ausonides* Lucas and the effect of density, mating behavior, feeding, and oviposition on movements. *E. ausonides* was studied in April, 1969, and during the springs of 1970 through 1972, at near sea level on Point Richmond, Contra Costa County, California (Fig. 1).

METHODS

The methods used are mainly those of Scott (1974). Butterflies were marked individually using the method of Ehrlich & Davidson (1960), and immediately released at the site of capture. Marking was done throughout the area; numbers (Fig. 1) were used to aid in pinpointing the exact site of each capture. On a map of the movements of each recaptured individual, various distances were measured (Table 1). Midpoint age between captures is determined by finding the age midway between two captures after designating the first capture day 0. Correlations between distances or velocities and midpoint age determine whether movements change with age.

RESULTS

Description of movements. A mark-recapture study was conducted in April, 1969. Individuals were marked and released over the portion of the hill south of area 38 (Fig. 1), and recapturing was carried out over

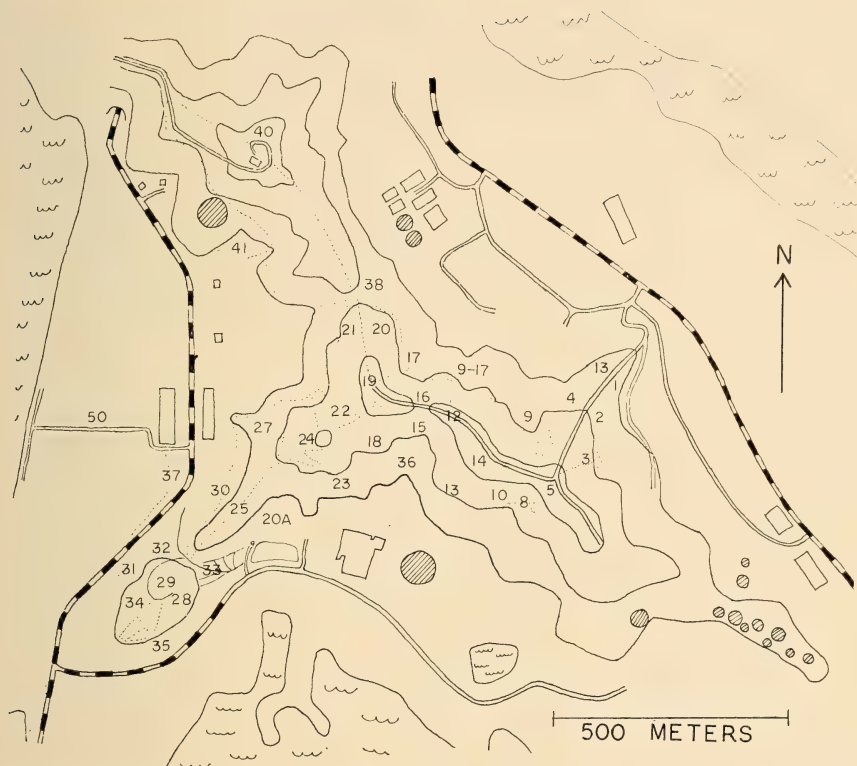


Fig. 1. Study area at Point Richmond, Contra Costa County, California. Numbers are markers used as aids in locating capture sites. Double lines are dirt roads. Round circles are tanks. Polygons are buildings. Contour interval 30 meters (maximum elevation 112 m).

the entire hill. Movements varied from none (over periods of several days) to large [one male traversed the entire hill four times in three days, and moved 1460 meters (air distance) in one day]. Movement parameters were greater for females than for males (Table 1). Total distance (D) was greater for males but range and velocities were greater for females; apparently females move more unidirectionally, while males tend to stay in one area more than females. Females are very good colonizers; I found eggs on introduced *Brassica nigra* plants at the Berkeley, California marina (created by dumping dirt into the bay), which is about three miles from the nearest colony. Movements do not change significantly with age; correlations between midpoint age and movement parameters (Table 1) were very small.

Effect of density on movements. To determine whether the large

TABLE 1. *Euchloe ausonides* movement data. Sample size of capitalized statistics is number of individuals recaptured; sample size of subscripted statistics and correlations is total number of recaptures. $n =$ not significantly different from 0 (test of zero correlation).

Movement parameter	Definition prior to averaging	Males	Females
Number marked		97	48
Number recaptured		54	19
Total number of recaptures		110	25
Ave. T (days)	Days between first and last capture	4.43	4.00
Ave. t_i (days)	Days between i 'th and $(i+1)$ 'th capture	2.17	3.04
Ave. R (meters)	Meters between the two farthest capture points	329.	366.
Ave. D (meters)	Sum of all d_i 's of an individual	463.	387.
Ave. d_i (meters)	Meters between i 'th and $(i+1)$ 'th capture	227.	294.
Ave. V (meters per day)	D/T	139.	179.
Ave. v_i (m/day)	d_i/t_i	161.	183.
Correlation d_i and t_i		+.036 ⁿ	
Partial correlation d_i and t_i , age constant		+.041 ⁿ	
Correlation v_i and age		+.126 ⁿ	
Correlation d_i and age		+.132 ⁿ	
Partial correlation d_i and age, t constant		+.133 ⁿ	
Correlation t_i and age		-.029 ⁿ	

TABLE 2. Population size estimates for *Euchloe ausonides* using five different methods.

Method	Population Size	
	Males	Both Sexes
Jolly (1966)	100	200
Craig's method 1 (Southwood, 1966)	—	227
Craig's method 2 (Southwood, 1966)	—	218
Edwards & Eberhardt (1967) method 1	—	368
Edwards & Eberhardt (1967) method 2	—	376

flights observed were due to overcrowding, population size was determined from 19 to 27 April using five different methods (Table 2). Jolly's (1966) method is probably the best (Southwood, 1966) as daily survival rates are probabilities rather than exact values. Estimates using the methods of Edwards & Eberhardt (1967) seem too large (Table 2). Because the density is the lowest of all eleven species of diurnal Lepidoptera that I have studied, I believe that density alone did not increase dispersal.

Effect of mating behavior on movements. The method of locating mates may play a part in movements of males. Males fly (patrol) all day about a meter above the ground searching for females. Males approach white paper models and other light butterflies (*Coenonympha tullia californica* Westwood and *Pieris rapae* L.) and other *Euchloe* individuals to within about 20 cm, then either turn away and continue flight, or hover in courtship. Females fly almost continuously also. Both sexes fly at a rapid rate of about 5 meters per second, and often travel 100 meters or more without stopping.

Weather affects this flight activity considerably: cloud cover, cold, and high winds curtail activity. Basking, either with the wings spread nearly to the sides or with the wings closed, and with the wing surfaces oriented nearly perpendicular to the sun's rays, may permit activity during less favorable weather.

Mating occurs at all times of the day whenever weather is suitable. Six copulating pairs were found from 0934 to 1552 (24-hr. ST), and 22 courtships were observed from 0850 to 1630. If a flying male encounters a flying female, they first hover near each other, with the male behind. Next the female lands and the male lands behind her and bends his abdomen to clasp hers. Once I observed a female remaining quiescent on a flower while the male landed and initiated copulation. Females

often mate more than once (of 39 wild females dissected, one had no spermatophores, 27 had one, 10 had two, and one had three).

Females reject males by means of two stereotyped behavior patterns. (1) Resting females spread the wings flat and raise the abdomen almost vertically; this posture is used by unreceptive females of most Pieridae (Scott, 1973b). The male may hover over the posturing female for up to 20 minutes in the case of young newly mated females. If the female was mated and apparently older, the male usually flew away after less than 30 seconds. Females in this posture alternately open and close the terminal abdominal flaps, exposing an elaborate apparatus consisting of six membranous lobes. (2) In a few instances, the female (with male behind) rose in the air as high as seven meters before the male flew away. In many other instances of discontinued courtship, both sexes began hovering, but then the male (or occasionally the female) merely flew away. Because females can rapidly discourage males, harassment by males probably has little effect on female movements.

Mating and courtship occurred everywhere on the hill. However more patrolling males and courtships were seen in hollows and valley bottoms than on ridges. This tendency to follow valley bottoms may contribute to longer movements because it promotes more unidirectional flight.

Effect of feeding on movements. Both sexes often feed on flowers, especially during warm weather. They prefer flowers of the main larval host, *Brassica nigra*, and often visit another crucifer, *Raphanus sativus*. Occasional visits were made to flowering plants of other families, including *Cirsium* sp., *Achillea* sp., *Plantago lanceolata*, *Brodiaea pulchella*, *Erodium* sp., *Eschscholtzia californica*, *Wyetha helenoides*, *Sisyrinchium bellum*, *Althaea rosea*, *Rubus* sp., and *Ranunculus* sp. The favored cruciferous flowers were widespread. This may have increased movements somewhat, but individuals do not need to move the observed distances merely to locate flowers.

Effect of oviposition and larval foodplants on movements. Oviposition occurred throughout the day from 0917 to 1507. Eggs are laid singly in the middle of the unopened flower buds of crucifers. If a plant has more than one such inflorescence, more eggs are found on the terminal inflorescences than on lower ones. Females almost always lay only one egg per plant, and then usually fly more than three meters before laying another. At the study site, plants usually had from one to several eggs, but one plant had ten eggs on it. Hundreds of eggs were found there on *Brassica nigra*, but three eggs were found on *Raphanus sativus*, a less common species. Adults were raised from larvae found on *B. nigra*. Larvae feed on the reproductive parts of the plant, and may destroy a

considerable part of the potential seed-producing structures. The following additional crucifers have been recorded either as larval hostplants or as oviposition sites of *E. ausonides* in other areas: *Descurainia californica*, *Arabis drummondi*, *A. fendleri*, *A. glabra*, *Erysimum capitatum*, *Sisymbrium altissimum*, and *Brassica kaber* (Remington, 1952; Shields et al., 1969; P. Opler, pers. comm.; Riotte, 1968). Oviposition behavior of females certainly is correlated with long-range flights of females, and many of the larval foodplants are plants of disturbed habitats, having a weedy distribution, which must favor large movements as well.

DISCUSSION AND CONCLUSIONS

There can be two main reasons for long-range flights in a population: (1) movements may be largely due to past long-term selective pressure, or due to the (2) short-term necessity for locating vital "resources" such as flowers, oviposition sites, and mates. I think that large flights of *E. ausonides* are mainly a hereditary response to past selection for locating these resources, first, because so many other species of Pieridae have apparently large movements (e.g., *Colias eurytheme* Boisduval, Stern & Smith, 1960; *Pieris protodice* Boisduval & Le Conte, Shapiro, 1970; *Ascia monuste* L., Nielsen, 1961), and, secondly, because movements of the sexes are very similar despite differing short-term necessities (mates and flowers for males, flowers and oviposition sites for females, although the distribution of virgin females must be roughly similar to the distribution of oviposition sites; males carrying the main burden of locating mates). In *E. ausonides* there is selection for long-range flights of females because of single oviposition on the widespread, weedy larval foodplants, which at the study site are introduced, early successional plants. These plants may attain high densities and then die out as plant succession proceeds; *E. ausonides* must disperse from regions having declining plant populations to areas where the foodplants are colonizing. Flight patterns of males must be roughly similar to flight patterns among females in order to locate mates. The greater movements of females than males seem to be due to the oviposition behavior of females, and the necessity for females to colonize new habitats. Adults need not remain near the larval hostplants for nectar, because they do not feed only on the flowers of the larval hosts, and they must emerge before the larval hosts complete blooming, in order to oviposit on flower buds.

The population density at the study site apparently did not cause long-range flights.

The sites of mate-locating behavior may affect movement. Males often fly up and down valley bottoms, and in forests fly mostly along valleys,

roads, and clearings. The use of these relatively linear paths may produce greater dispersal than would occur in populations in which individuals turn randomly.

The process of mating itself seems to have little effect on movements. Courtship and mating are brief, and lack the long-distance postnuptial flight of other species such as is found in *Danaus gilippus* Cramer (Brower et al., 1965). Males apparently are not drawn to females from long distances by pheromones but seem to locate females visually. Males have androconial scales on the forewings (Opler, 1969), but in *Colias* such scales do not disseminate a pheromone (R. Silberglied, pers. comm.). The terminal abdominal lobes of females possibly emit a pheromone to repel males (Scott, 1973b), but males were not attracted by several virgin females released at the study site.

ACKNOWLEDGMENTS

I thank Paul A. Opler for helpful information, and Robert Silberglied and Jerry Powell for reviewing the manuscript.

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RECORDS OF *LYCAEIDES MELISSA SAMUELIS*
(LYCAENIDAE) FROM WISCONSIN

One of us (FHK) discovered a large flourishing colony of *Lycaeides melissa samuelis* Nabokov in the Seymour Township School Forest Reserve, Eau Claire County, Wisconsin on 28 May 1972. We both returned to this locality many times during 1972 to collect additional specimens, and several other colonies were discovered in an approximate 10 mile radius of the original site. Collecting dates during 1972 included May 26 and 31; June 3, 5, 6, 12, 15, 19 and 25; July 4, 5 and 7; and August 20 and 26. There appear to be at least two and possibly three broods.

The habitat where these colonies were found was fairly typical of Pine Barrens, although somewhat disturbed by plantations of *Pinus resinosa* (Red Pine). The soil is very shallow and sandy; dominant native trees are *Pinus banksiana* (Jack Pine) and *Quercus ellipsoidalis* (Hill's Oak); prevalent groundlayer plants include *Vaccinium angustifolium* (Blueberry), *Viola* sp. (violets including the rare *Viola pedata*), *Lupinus perennis* (Blue Lupine), *Arabis* sp. (Rock Cress), *Lithospermum* sp. (borage) and *Amorpha canescens* (Leadplant). Other, somewhat habitat restrictive, species of diurnal Lepidoptera which occurred here included: *Amblyscirtes samoset* (Scudder), *Wallengrenia otho* (Smith), *Hesperia sassacus* Harris, *Incisalia polios* Cook & Watson, *Incisalia niphon* (Hübner), *Glaucopsyche lygdamus* (Doubleday), *Chlosyne gorgone* (Hübner), and *Speyeria aphrodite* (Fabricius).

We both visited the colony together on June 19 and observed a female *Lycaeides melissa* ovipositing on *Lupinus perennis*. She spent a great deal of time flying over the plant, then landed and walked up and down the leaflets and stems. She would stop occasionally and make false attempts at depositing an egg. After about five minutes of observation, she paused on top of a leaflet and then, twisting her abdomen in an arc, she deposited a green egg at its edge on the lower surface.

All previous records of *Lycaeides* from Wisconsin have been attributed to *argyrognomon* (Bergstrasser), recently described as subspecies *nabokovi* Masters (1972, *J. Lepid. Soc.* 26: 150-154). These records of *L. argyrognomon*, a species extremely hard to distinguish superficially from *L. melissa*, include Marinette and Oconto Counties (Griewisch 1953, *Lepid. News* 7: 54), Brown, Waupaca, Shawano and Burnett Counties (Ebner 1970, *Milwaukee Public Mus. Popular Sci. Hbk.* 12) and Portage County (Johnson & Malick 1972, *Rpt.* 7, *Mus. Nat. Hist., Univ. Wisc., Stevens Point*). There is little doubt, however, that these new populations in Eau Claire County represent *L. melissa* and not *argyrognomon*. The identification is determined by maculation (the ventral hindwing margins tend to have a solid terminal line), male genitalia dissection (JHM), the foodplant (*Lupinus*), the habitat (Pine Barren instead of Canadian Zone Forest), and the existence of multiple annual broods. In addition we highly suspect that the specimens recorded from Burnett and Portage Counties should be properly attributed to *L. melissa* instead of *L. argyrognomon*. Our reasoning for this is that Pine Barrens occur in Burnett County and Oak Barrens in Portage County, but true Canadian Zone Forest occurs in neither.

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NOTES ON THE LIFE CYCLE AND NATURAL HISTORY OF
BUTTERFLIES OF EL SALVADOR. V.
ANAEA (MEMPHIS) MORVUS BOISDUVALI (NYMPHALIDAE)

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This is the fifth article of a series relating what my sons and I have found with respect to the life cycle and natural history of the butterflies that occur in the neighborhood of San Salvador, capital of the Republic of El Salvador. As stated in one of our prior articles, we undertook the present task because of the exiguous literature on the early stages of many Neotropical species of butterflies. This is particularly true of the genus *Anaea*. We hope to fill as much of the existing gap as our limited capacity allows, thus facilitating the completion of the job by the experts. In addition to the series of articles, specimens of the early stages of the species described are being placed with museums so as to be available to students of the groups.

Anaea (Memphis) morvus boisduvali Comstock, is, if not scarce, so elusive as to seem scarce in this country. During eight years of collecting and observing local butterflies, we have seen only about twenty adult specimens of this species, half of them in local collections, including ours. Again my younger son accidentally found first instar larvae of "a new *Anaea*" during September 1972. (In November 1970 he discovered the foodplant of *Morpho polyphemus polyphemus* P. & H. and in December 1971, the foodplant of *Prepona omphale octavia* Frühstorfer.) Having located the foodplant, it was a matter of patience to see a female ovipositing. When this happened, we first thought the female was *Anaea (Memphis) pithyusa* R. Felder using the "new *Anaea*'s" foodplant as an alternate choice, as both species resemble each other. We still collected the eggs, but after some moults it was evident that it was the "new" species. On that day we collected eight eggs and 11 first and second instar larvae.

The material was kept in transparent plastic bags containing only fresh leaves of the foodplant. The leaves were kept fresh by sticking them into a wad of cotton covered by a smaller plastic bag containing water. It was noticed that the larvae that fed on slightly decaying leaves invariably died. Photographs were made of all stages of development, records were kept of developmental time and measurements of each instar were taken. Specimens of the early stages were preserved in

alcohol. The bags with the living material were kept at all times under ambient light and temperature conditions. Since then we have collected larvae of this species during October–January.

Life Cycle Stages

Egg. Translucent white with greenish tinge, almost spherical with flattened base and shallow depression at micropyle. About 1 mm diameter. All hatched in 5 days.

First instar larva. Head roundish, dark brown with darker markings. Body dark brown with annulets between segments. Cephalic end of body thicker than caudal end. Grow from 2 mm to about 3.2 mm in 6 days.

Second instar larva. Head dark brown with small stubby horns at apex of epicrania. Body dark brown with a profusion of paler, tiny tubercles that form rings around segments. Grow to 0.5 or 0.6 cm in 5 days.

Third instar larva. Head thicker than body at first, brown, with many pale, small tubercles scattered mostly along sides. Stubby black horns at epicrania, with small tubercles bearing clear setae. Alternate black and light brown vertical bands in frontal area. Body grayish brown, with dark brown, almost black patch covering lateral area from prothorax to first proleg, slanting up from prothoracic spiraculum to subdorsal area in second abdominal segment, then abruptly down to subspiracular zone in third abdominal segment. A second dark area starts on fifth abdominal segment covering supraspiracular zone, diffusing caudad. Whole body crossed dorsally by rings of pale tubercles bearing minute setae. Larvae grow to about 1.1 cm in 5 days.

Fourth instar larva. Similar to third stadium. Head about as thick as body, with slightly bigger tubercles at sides. Tubercles, pale, each bearing a pale seta. Original pair of horns bigger, with noticeable tubercles; a second pair of horns anterior to first ones, small and thick. Light bands in front of head more contrasting. Body as in third stadium, but with olive tinge in certain individuals, reddish in others. The rings of pale tubercles and their setae more prominent. Grow to approximately 2.1 cm in 5–7 days.

Fifth instar larva. Head black with light bands: two from ocelli to epicranial horns, which are much reduced; two more bands converging, laterally bordering adfrontal sutures; two medially bordering adfrontal sutures, prolonging to labrum. Whole head covered with small, pale tubercles. Each tubercle bearing pale seta. Tubercles at sides of epicrania bigger, with longer setae. Body dark brown with olive or reddish tinge, with rings of small pale tubercles with pale setae contrasting against dark body. Spiraculum on first thoracic segment much bigger than the others, which are inconspicuous. Bases of prolegs bear tufts of light setae making the larvae appear hairy. Grow to 3.2–3.5 cm in 14–21 days.

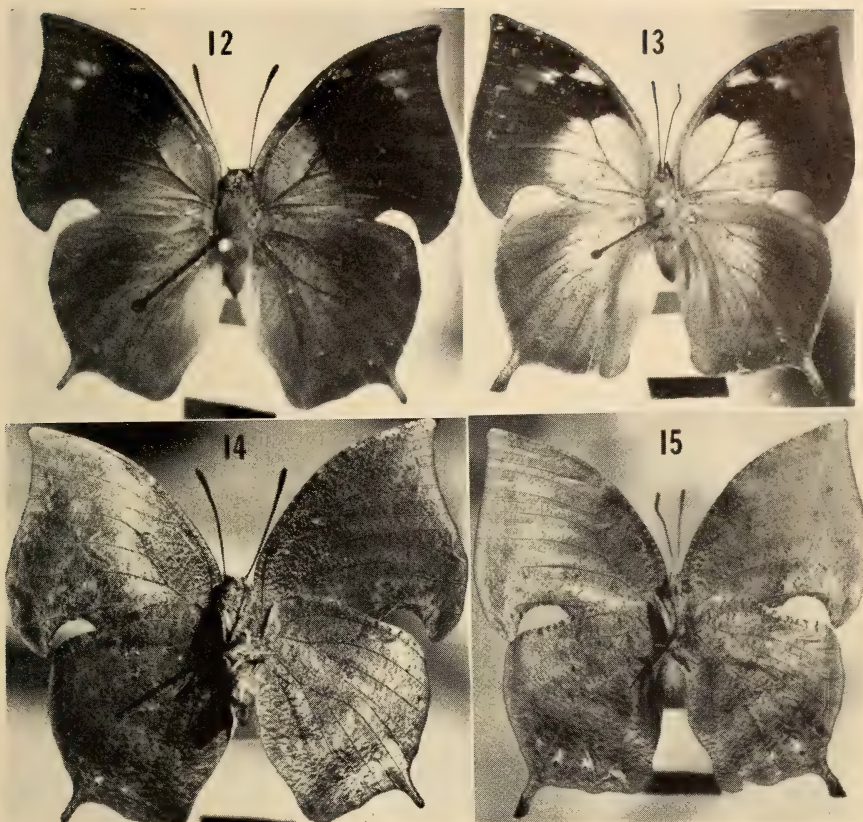
Prepupa. Body shortens considerably and becomes lighter brown. Stays incurved laterally for one day.

Pupa. Very pale brown with dark brown markings mostly dorsally, giving it a marbled appearance. Black, elaborated cremaster directed at right angle to plane of body. Abdomen rounded and incurved ventrally, with wing cases reaching close to cremaster. Thorax slightly keeled dorsally. Whole pupa formed by smooth curves without ridges or sharp angles. Spiracula inconspicuous light brown. Measures 1.5 cm long, 0.9 cm dorsoventrally at widest point, and 0.9 cm laterally at widest point. Duration 10–11 days.

Adults. Apex of forewing more-or-less acute, outer margin more-or-less sinuate, inner margin with emargination near tornus. Hindwing rounded with tail thin in males, spatulated in females. Anal angle rounded.



Figs. 1-11. *Anaea (Memphis) morvus boisduvali* Comstock. 1, Egg, width about 1 mm; 2, first instar larva, length about 2.5 mm; 3, second instar larva (on prolonged vein), 6 mm long; 4, third instar larva, 11 mm long; 5, fourth instar larva, about 21 mm long; 6, fifth instar larva, about 34 mm long; 7, prepupa showing characteristic lateral incurvation; 8, detail of head; 9, lateral view of pupa, about 15 mm long and 9 mm dorso-ventrally; 10, dorsal view of pupa, about 9 mm wide; 11, ventral view of pupa.



Figs. 12-15. *Anaea (Memphis) morvus boisduwali* Comstock adults. 12, Dorsal view of male, about 4.1 cm span between tips of spread front wings; 13, dorsal view of female, about 4.6 cm span between tips of spread front wings; 14, male, ventral view; 15, female, ventral view.

Males dorsally dull black on both fore- and hindwings, with dark blue reflection basally from midcostal area of forewing to tail on M3 vein of hindwing. Variable number of dark blue spots present subapically on forewing, forming a rough semicircle from costal margin to outer margin. Hindwing has discolored fold alongside inner margin.

Females dorsally dull black with light blue on both wings basally, reaching discal area. On hindwing light blue continued by darker blue reflection to tail on M3 vein and to anal angle. Subapically in forewing, light blue spots present starting at costal margin. As in males, discolored fold present alongside inner margin on hind wing.

Ventrally both sexes dark brown (darker in males), with grayish reflection, with some pale spots alongside outer margin, between tails and anal angle.

Body in both sexes has same shade as base of wings, from above and underneath. Eyes and proboscis light brown, antennae black. Females usually larger than males: 4.6 cm and 4.0 cm between tips of spread wings respectively.

Total developmental time varied from 51–61 days, females usually taking longer than males.

Natural History

We have found the eggs and larvae of *A. morvus boisduvali* consistently on one species of Lauraceae, identified by Lic. Jose Salvador Flores, Universidad Nacional, as *Nectandra sinuata* Mez. This plant, which grows to small tree size, is seen in shady ravines of the San Salvador volcano. The oblong coriaceous leaves, 10–25 cm long, give a strong scent when rubbed.

About Lauraceae in general and *Nectandra* in particular, we have found the following: "*Toutes les Lauracées contiennent des cellules à huile essentielle.*" (Beille, 1909). "*Les Lauracées sont essentiellement des plantes aromatiques . . . Leur feuilles . . . sont souvent parsemées de réservoirs pellucides et punctiformes, gorgées d'huile essentielle, odorante et volatile.*" (Baillon, 1870). According to Standley (1922) a close relative of this species, *Nectandra rodiaei* Hook, contains several alkaloids: beeberine, sipirine and nectandrine, in addition to the essential oils.

Upon emerging, the tiny larvae completely eat the egg shell and remain under the leaf without feeding for a time, moving later to the edge of the leaf where they nibble around a vein, baring it. This vein is used from then on as a resting place and is covered with frass and silk. The larvae usually keep their head pointing outwards, and all through the first, second and third stadia they abandon this vein only to feed very early in the morning or in the evening. During the fourth stadium the larvae start wandering about, moving slowly, until they select a leaf where each builds a hiding place by folding an edge of the leaf forming a narrow funnel about 3.5 cm long, with the interior lined with silk. Again the larvae only leave this refuge for feeding purposes at dawn and at dusk. The wide end of the funnel is effectively blocked by the massive head of a larva and the narrow end is used to eject the excreta. As all Charaxinae we have reared, the larvae of *A. morvus boisduvali* are very slow moving and passive during all their development. When prodded with a stiff brush, they sometimes react by making pushing motions with their tubercled head. We could not detect in this species any scent nor the extrusion of the gland cephalad the prothoracic legs as in other *Anaea*.

When ready to pupate the larvae abandon for good their funnel, and locate a suitable pupation site. There they form a button of silk in a place vertical to the ground and fasten their anal prolegs thereon. Their body shows a general discoloration and a noticeable shortening. During

this short period the larvae do not hang as most Nymphalidae do, but stay incurvated laterally, as do all other *Anaea* spp. in this area.

The pupae, due to the angle formed by the cremaster in relation to the body, remain vertical to the ground, even if affixed to a vertical twig or drooping leaf. They are rather stiff and seldom react. When handled they occasionally make lateral movements.

Adults emerge from the pupa shell very rapidly and are ready to fly in less than 20 minutes. They expel an amount of reddish meconium.

As for the behavior of the adults of *A. morvus boisduvali* very little can be said with certitude. On the wing they look very much like the locally more abundant relative *A. pithyusa*, and therefore, the observations might be confusing. It is only when the adults are feeding that they can be closely approached, making it possible to accurately identify them. We do know that both sexes are strong flyers and favor woody areas and shady ravines where their foodplant is found, usually keeping near treetops. The adults also visit the ground to feed on fermenting fruits (avocados, mangoes, guayavas, etc.) and on vertebrate excrements. They feed avidly for long periods of time, and this is the only time they loose their usual alertness. They are very responsive to baits, and while at the bait they can be netted rather easily. The adults mimic dried leaves while at rest.

Discussion

According to Comstock (1961) nothing has previously been published on the life cycle of *A. morvus boisduvali*. Information about the life history of a close relative, *A. morvus stheni* Prittwitz, was published by Müller (1886).

The eggs of *A. morvus boisduvali* have the same size, shape and color as the eggs of other *Anaea* spp. found in El Salvador, with the exception of *A. (Zaretis) itys* Cramer and *A. (Siderone) marthesia* Cramer. The eggs of these species have a yellowish tinge instead of greenish. *A. marthesia* also has eggs that are bigger and more flattened at the micropyle than *A. morvus boisduvali*. The eggs are very hard to find because the female deposits them singly on the shadowy underside of mature leaves. The early stages of the larva also very much resemble the other *Anaea*, with the exception of the two mentioned species. But from the fourth stadium on, there is marked difference in appearance from all the others. This is true also for the pupa.

The defense strategy is based on crypsis, the same as the majority of the local species, *A. (Consul) fabius* Cramer, *A. (C.) electra* Westwood,

A. (Memphis) euryppyle confusa Hall and *A. (M.) pithyusa*, i.e., the bared vein during the initial instars and the funnel-shaped refuge during the latter.

The pupae of *A. morvus boisduvali* have a coloration mimicking, remarkably well, a common snail which is found on the leaves of shrubs and trees. The swift flying adults exploit the flash and hide effect caused by their dorsal blue reflection and their dead leaf ventral coloration.

It is possible that *A. morvus boisduvali* also derives protection from its larval foodplant, *Nectandra sinuata*, which is engorged with essential oils and, perhaps, alkaloids in addition to its complex cryptic behavior. This would be similar to the situation of the *Aristolochia* feeding Troidini. The species may also be part of a Müllerian mimicry complex with the closely related *Anaea pithysusa*. The latter also feeds on very aromatic and bitter plants, *Croton reflexifolius* H. B. K. and *C. niveus* Jacquin (Euphorbiaceae). Experiments to investigate these possibilities are needed.

The eggs of this species are parasitized by a tiny Chalcidoidea wasp that also parasites other *Anaea* spp. We have not found cases of parasitism during the larval stage, as so often happens with the other species, by a Tachinidae fly identified as *Crysotachina* sp. by Dr. C. W. Sabrosky, U. S. National Museum. One observed cause of mortality during the first and second instars is a fungus that mummifies the larvae while on their bared vein.

Heavy predation by spiders is strongly suspected, because we frequently found spiders on leaves bearing an empty bared vein. This would seem to eliminate the possibility of this species being totally unpalatable. We have observed spiders preying on larvae of other species of families considered distasteful to predators based on experimentation (Brower, et al., 1963; Brower & Brower, 1964; Benson, 1971). Included in our records are *Heliconius charitonius* L., *Dryas iulia iulia* (Fabricius) and *Agraulis vanillae incarnata* Riley, all Heliconiidae. We also have seen massive predation by lizards on larvae of *Dione iuno huascama* Reakirt (Muyshondt, Young & Muyshondt, ms. in prep.).

The most common cause of mortality in this species in our insectary has been caused by feeding the larvae slightly decaying leaves of the foodplant, which apparently become toxic to them.

The scarcity of the species in El Salvador suggests either low fertility or a high rate of mortality during the early stages due to causes other than parasitism, or a combination of the two factors.

ACKNOWLEDGMENTS

We are thankful to Stephen Steinhauser who besides identifying this species, gave us free access to his technical library, to Lic. Jose Salvador Flores, Universidad Nacional, who identified the foodplant, and to Dr. C. W. Sabrosky, U. S. National Museum who made the Tachinidae determination. We are indebted also to Dr. T. D. Sargent, University of Massachusetts, who read our manuscript and gave valuable criticism. Once again we give due credit to the younger boy in the family, Pierre, who found the foodplant of this species.

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AN ANNOTATED ENTOMOLOGICAL BIBLIOGRAPHY OF ROMUALDO FERREIRA d'ALMEIDA (1891-1969)

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For almost fifty years d'Almeida ranked among the leading entomologists of the Americas. His greatest contributions to lepidopterology are in the fields of life histories and nomenclature. In the course of these studies he found it necessary to carry out many taxonomic investigations and reviews. During his lifetime he published over a hundred papers, some a single page, some thick volumes. Many of these papers are of great importance to students of butterflies and moths throughout the Americas. Unfortunately good runs of publications from South American institutions are relatively rare in North American libraries. Because of this I have prepared notes from each of d'Almeida's papers, thus extending the usefulness of this bibliography.

The items in this list were assigned numbers by Prof. Olaf H. H. Mielke and me. They follow very closely the numbers d'Almeida placed on copies of his papers sent to me. Through number 58 they are the same as the numbers used in the bibliography of d'Almeida's papers included in the festschrift issued in his honor. Beginning with number 59 we diverge from that bibliography. Numbers followed by an asterisk (*) are papers that I have not seen. All of the titles and citations in this listing have been meticulously checked by Prof. Mielke, d'Almeida's scientific heir. For this I am very grateful.

- 1.* Trois lépidoptères nouveaux du Brésil. Rio de Janeiro. 2 p. (1913).
Hesperocharis melissa, n. sp., Rio de Janeiro; *Appias drusilla* f. *nana*, n. var. [Serra dos Prétos Forros,] Rio de Janeiro; *Terias tenella* ab. n. ♀ *alcides*, Rio de Janeiro.
2. Notes sur quelques lépidoptères d'Amérique du Sud. Ann. Soc. Entomol. Fr. 90: 57-65 (1921).
Life histories of *Papilio agavus* Drury, *Appias drusilla* Cramer, *Perrhybris pyrtha* Cramer and *Terias tenella* Boisduval. The following nova are described: *Appias drusilla* f. ♀ *nana*; *Terias tenella* f. ♀ *panopea*, f. ♀ *germana*, f. ♀ *jacarepaguana*, ab. ♀ *alcides*; *Terias lepidula*, n. sp. from Jacarépaguá, Rio de Janeiro; and *Catopsilia fluminensis*, n. sp. from Corcovado, Rio de Janeiro.
3. Mélanges Lépidoptérologiques. I, Études sur les Lépidoptères du Brésil. R. Friedlander & Sohn, Berlin. ix + 226 p. (1922).
Life histories of about 100 butterflies and 6 moths, ranging from a single stage to complete and detailed accounts. Thirty new names are proposed: *Terias singularis*, n. sp., Pavuna de Jacarépaguá; *Catopsilia eubule* ab. *lichas*; *Catopsilia eubule* n. ab. *fugax*; *Leucidia maculata*, n. sp., Covança de Jacarépaguá; *Placidula*, n. gen., genotype *Ceratina euryanassa* Felder;

Dismenitis diversivoca, n. sp. Tres Rios, Jacarépaguá; *Dismenitis* (?) *pseudodiversivoca*, n. sp.; *Mansueta*, n. gen., genotype *Heliconia daeta* Boisduval; *Rhabdinoptera*, n. gen., genotype *Ceratina eupompe* Huebner; *Rhabdinoptera hymenaea* n. ab. *nebula*; *Rhabdinoptera hymenaea* n. ab. *stratoniceis*; *Pigritia*, n. subgen., (of *Rhabdinoptera*), genotype *umbraticola*, n. sp., Covança de Jacarépaguá; *Languida*, n. subgen., (of *Rhabdinoptera*), genotype *genetyllis*, n. sp., Caramujos; *Euptychia byses* n. f. *bimaculata*; *Euptychia pavunae*, n. sp., Parvuna de Jacarépaguá; *Euptychia herse* n. f. *bellatula*, Caramujos; *Euptychia arnaea* n. f. *priamis*, Tres Rios, Jacarépaguá; *Taygetis fulginia*, n. sp. Caramujos; *Taygetis celia* n. f. *magna*; *Actinote brasiliensis*, n. sp.; *Actinote pyrrha* n. ab. *magnifica*; *Actinote jordani*, n. sp.; *Actinote distincta*, n. sp.; *Actinote genitrix*, n. sp.; *Phyciodes landsdorfi* n. f. *veternosa*, Tanque, Jacarépaguá; *Dynamine arene* n. f. *argyripa*, Tres Rios, Jacarépaguá; *Stalactis susanna* n. ab. *pygmaea* Corcovado; *Xenandra agria* n. f. *petilius*; *Eurybia pergaea* n. ab. *ferruginea*; *Euselasia hieronymi* n. f. *unicolor*, Tres Rios, Jacarépaguá. (NB: all type localities are in the states of Rio de Janeiro or Guanabara.)

4. Notes sur quelques lépidoptères rhopalocères du Brésil. Ann. Soc. Entomol. Fr. 91: 229–235 (1923).

Life history of *Euptoietia hegesia* Cramer. New names proposed: *Morpho achilloena* ab. ♂ *benkoi*, Tres Rios, Jacarépaguá, Rio de Janeiro; *Actinote rhodope* n. sp., and n. f. *lynxa*, Tres Rios; Notes on Ithomiinae, especially *Rhabdinoptera* and its subgenera.

5. Contributions à l'étude des lépidoptères du Brésil. Bol. Soc. Entomol. Brasil 4–6: 13–14 (1923 [1924]).

The caterpillar of *Automeris larra* Walker, last stage and pupa: *Pyrrhoghya catharinae* Staudinger is female of *P. neoerea ophni* Butler: *Pigritia* d'Alm., 1922, antedated by *Pigritia* Clemens, 1860, and replaced by *Heringia* d'Alm.

6. Les Papilionides de Rio de Janeiro. Description de deux chenilles. Ann. Soc. Entomol. Fr. 93: 23–30 (1924).

Time table for generations per year for 13 species of *Papilio* in vicinity of Rio de Janeiro. Life histories of *Papilio dolicaon deicoon* Felder and *Papilio dardanus* Fabricius.

7. Quelques rectifications sur les *Actinote* de la partie orientale de l'Amérique du Sud (Lep., Rhopalocera). Ann. Soc. Entomol. Fr. 94: 333–354 (1925).

Corrects errors in "Mélanges Lépidoptérologiques" (item 3). Notes distinctive characteristics of five species found around Rio de Janeiro: *pellenea*, *brasiliensis*, *parapheles*, *genitrix*, *rhodope*. Life histories of the same species are given; also, synonymies. Nova are: *brasiliensis* ab. n. *fuliginosa*; *genitrix* ab. n. *subrubicunda*, and *moesa*, ab. n.; *parapheles fumida* n. var. ♀; and *hippea*, n. var. ♂. The annual cycle for each of the five species is given in a single table.

8. Contribution à l'étude des Rhopalocères américains (Lép.). Ann. Soc. Entomol. Fr. 97: 369–388 (1928).

Seven parts. I. *Papilio agavus* n. ab. *furvescens*, t. I. Tres Rios (Jacarépaguá), Rio de Janeiro. II. *Hesperocharis melissa* Ferr. d'Almeida is an ab. of *anguitia*; *Catopsilia eubule fugax* Ferr. d'Almeida = *drya* Fabr. III. "Étude sur le genre *Terias*": *arbela* ab. n. *rubella*, t. I. Venezuela; *arbela* ab. n. *lurida*, t. I. Tojujo, Peru; *tenella* ab. n. *cissa*, t. I. Rio de Janeiro; *elatheia* ab. n. *incana*, t. I. S. Tome. Arg. Rep.; *elatheia* f. n. *gracilis*, t. I. Mato Grosso; *phiale flavomaculata*, t. I. Jundiaby, São Paulo; *raymundoi* n. sp., Santo Tomé, Corrientes, Arg. Rep. IV. Note sur deux formes géographiques d'*Euptychia*. *E. herse bellatula* d'Alm. and *E. arnoea priamis* d'Alm. V. Recherches sur les générations des *Morphides* [*Morpho achil-*

- loena* Hbn.] VI. Note rectificative sur plusieurs espèces d'*Ithomiines*. The genus *Rhabdinoptera*. VII. Observations sur les *Heliconius* de Rio.: *phyllis* ab. n. *miletus*, t. l. Nova-Iguassu, Rio de Janeiro; *mayi*, n. sp., t. l. Nova-Iguassu, Rio de Janeiro.
9. Notes sur les papillons hétérocères du Brésil. Description de trois chenilles. Bull. Soc. Entomol. Fr. 34: 216-220 (1929).
Life history of *Halisidota schausi brasiliensis* Rothschild, and partials for *Robinsonia dewitzi* Gundlach and *Attacus belus* Maassen & Weymer.
 10. Étude sur le genre *Terias* (2me note). Rev. Chil. Hist. Nat. 33: 421-427. 1 fig. (1929).
Limited synonymies and notes for seven species. *Terias porteri*, sp. n., Quito, Ecuador.
 11. Quelques notes pour servir a l'histoire naturelle des lépidoptères américains. Lambillionea 31: 83-88 (1931).
I. Considérations sur plusieurs genres de lépidoptères.
II. Quelques races et aberrations de papillons. Description d'une aberration nouvelle. *Adelpha cocala riola* Fruh. ab. n. *chlida*, t. l. Mont Cavallão, nr. Nictheroy, Rio de Janeiro. Life history of *riola*. Notes on *Daptonoura*.
 12. Beiträge zur Schmetterlings-Fauna Süd-Amerikas. Entomol. Zeitschr. (Frankfurt) 45: 59-61. 3 figs. (1931).
Actinote rhodope ab. n. *tenuilimbata*, Rio de Janeiro; *Callicore difascia*, Colombia; *Heliconius nanna* Stichel (= *mayi* d'Almeida, 1928, see item 8).
 13. Bemerkungen über einige Schmetterlinge aus Brasilien. Entomol. Zeitschr. (Frankfurt) 45: 232-235. 3 figs. (1931).
Dismorphia dissimulata, n. sp., Tres Rios, Jacarépaguá, Rio de Janeiro; *Dismorphia aegima*, n. sp.?, Tres Rios, Jacarépaguá, Rio de Janeiro. Notes on two Erycinidae.
 14. Les Erycinides du Brésil. Lambillionea 32: 13-14. 1 fig. (1932).
Aricoris ? *ambigua*, n. sp., Tres Rios (Jacarépaguá), Rio de Janeiro.
 15. Les premiers états d'un Diophtidae. Lambillionea 32: 15-16 (1932).
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 16. Étude sur le genre *Terias* (3e note). Bull. Soc. Entomol. Fr. 37. 44-47. 1 pl. (1932).
T. platoea Felder not a synonym of *elatheia* Cramer; *T. proterpia* ab. n. *imitatrix*, Colombia; *T. phiale majorina* n. ssp., Rio de Janeiro.
 17. Quelques légères remarques sur plusieurs groupes supérieurs de lépidoptères américains. Lambillionea 32: 166-171 (1932).
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 19. Le *Syntemeida melanthus albifasciata* Butlr., et ses premiers états (Lep. Syntomidae.) Lambillionea 33: 209-212.
Complete life history.
 20. Les chenilles des genres *Hemiargus* et *Leptotes* (Lep. Lycaenidae.) Lambillionea 33: 230-236 (1933).
Complete life histories of *H. (Leptotes) cassius* and *Hemiargus gyas zachaeina* ? Butler in Rio de Janeiro. Notes odoriferous retractile tentacles on the dorsum of segment 10 of *cassius* and *gyas*. Also comments on retractile organs on ventrum of prothorax anterior to the first pair of true legs of Morphids, Brassioides and certain Nymphalids (e.g., *Ageronia*, *Gynaecia*, etc.)

21. Étude sur le genre *Terias* (4e note.) (Lep. Pieridae.) Bull. Soc. Entomol. Fr. 38: 298–300 (1933 [1934]).
T. riograndensis, n. sp., Rio Grande do Sul; *T. pseudoleuce*, Port-of-Spain, Trinidad.
22. Étude sur le genre *Dismorphia* Hübn. (Lep. Pieridae.) Bull. Soc. Entomol. Fr. 38: 300–304 (1933 [1934]).
D. limnoria hoffmanni, n. ssp., Sta. Catherina; *melite* f. *melite*, further description; *melite liberata* n. ssp., Rio de Janeiro; *D. melite clarissa* abb. n. *simulatrix*; *flavescens*, from Sta. Catherina.
23. Zwei neue Schmetterlinge aus Brasilien. Entomol. Zeitschr. (Frankfurt) 38: 90–92. 3 figs. (1934).
Actinote travassosi, n. sp., Angra dos Reis; *Callicore lyde*, n. sp., Tres Rios (Jacarépaguá); the first is in the state of Rio de Janeiro; the second in Guanabara.
24. Studien über die Gattung *Terias*. (Fünfte Note.) Entomol. Zeitschr. (Frankfurt) 48: 115–118. 3 figs. (1934).
 Numerous notes. *Terias lye*, n. sp., Havana, Cuba; *thymetus pauperata* n. ssp., Cuba; *graduata clarescens* n. ssp., Tarapoto, Peru, etc.
- 25–26. Les *Actinote* de la partie Orientale de l'Amerique du Sud. Ann. Acad. Bras. Sci. 7: 69–88, 89–112. 13 pls. (1935).
 Ten species are discussed in detail with many variations noted and a few named. *A. pellenea carycinoides* n. ssp. (ex larva); *A. pellenea nordestina* n. ssp., Alagoas and Parahyba du Nord; *A. carycina hoffmanni*, n. ssp.; Sta. Catherina; *A. carycina differens*, n. ssp., Sta. Catherina; *A. brasiliensis discolora*, n. n., for *A. b. pyrrha* d'Almeida, 1922, not Fabricius, Butantan, São Paulo; *A. brasiliensis notabilis*, n. ssp., Rio de Janeiro; *A. rhodope fuscata*, n. ssp., Rio de Janeiro; *A. parapheles* ab. n. *discrepans*, Sta. Catherina; *A. parapheles* ab. n. *umbrata*, (ex larva) Angra dos Reis, Rio de Janeiro. Life histories for: *pellenea*, *brasiliensis*, *rhodope*, *parapheles* and *genitrix*.
27. Lista dos lepidopteros capturados pelo Dr. R. v. Ihering no nordeste do Brasil. Rev. Ent. (Rio de Janeiro) 5: 326–328 (1935).
 Thirty-three butterflies and 21 moths taken in the states of Parahyba, Rio Grande do Norte and Pernambuco.
28. Nota suplementar [sic] ao nosso artigo sobre o género *Actinote* Hübn. Rev. Ent. (Rio de Janeiro) 5: 486–488. 5 figs. (1935).
 Comments on Hayward's notes on *Actinote* in Rev. Soc. Entomol. Arg., Vol. 4, 1931. Drawings of mature larvae of *A. genitrix* d'Alm., *brasiliensis* d'Alm., *rhodope* d'Alm., *parapheles* Jordan, and *pellenea* Huebner. Some synonymies proposed.
29. Lepidopteros do nordeste do Brasil. Rev. Ent. (Pequenas comunicações) (Rio de Janeiro) 5: 503 (1935).
 Adds *Ascia monuste orseis* Godt. to von Ihering's list of captures (See item 25).
30. *Terias plagiata*, nov. nom. Rev. Ent. (Pequenas comunicações) (Rio de Janeiro) 5: 504 (1935).
 The name *plagiata* is substituted for *gracilis* d'Almeida (item 8), a homonym of *Terias gracilis* Avinoff.
- 31–32. Revisão das *Terias* americanas. Mem. Inst. Oswaldo Cruz (Rio de Janeiro). Part I: 31: 11–54. 17 pls. Part II: 31: 189–247. 18 pls. (1936).
 Part I and II contain extensive synonymies of all American species and some new names. *T. rubricata* n. n. for *T. arbela* ab. *rubella* d'Alm., not Wallengren (item 8); *T. xystra* n. sp., Quito, Ecuador, in Part I. In Part II

there are life histories of *T. tenella*, *elathea*, *albula*, *agave* and *deva* as they are in the vicinity of Rio de Janeiro. No new names in this part.

33. Une nouvelle espèce d'*Iphiclides* (*Papilio*) du Brésil. Festschrift zum 60. Geburtstage von Professor Dr. Embrik Strand (Riga, Latvia), 1: 510-513. 4 figs. (1936).

Iphiclides (*Papilio*) *embrikstrandii*, n. sp., Wenceslau, São Paulo.

34. Une nouvelle espèce d'*Iphiclides* (*Papilio*) du Pará. Campo (Rio de Janeiro) 8 (85): 58 (1937).

Iphiclides aguairi, n. sp., Cachoeiro do Tronco, Rio Cuminá, Pará.

35. Excursão científica aos rios Cuminá e Trombetas. Mem. Inst. Oswaldo Cruz (Rio de Janeiro) 32: 235-298. 5 pls. (1937).

Four hundred eight-five butterfly and 171 moth species plus about 50 undetermined species, mostly Hesperidae, were collected. *Iphiclides aguairi* d'Almeida (see item 34) figured from the type. NB. Pl. 5, figs. 2 & 3 are transposed. Pages 284-298 enumerate other zoological material collected.)

36. [Travassos & d'Almeida] Contribuição para o conhecimento da bionomia de alguns lepidopteros brasileiros. Mem. Inst. Oswaldo Cruz (Rio de Janeiro) 32: 499-516. 2 pls. (1937).

Life histories of *Dysdaemonia tamerlan* Maasen & Weymer, *Automeris acuminata* Maasen & Weymer, *Dirphia multicolor* Walker; *Syssphinx molina* Stoll), *Citheronia phoronea* (Cramer) and *Machaerosema martii* (Perty).

37. Notes synonymiques sur les Lépidoptères Américains. Lambillionea 37: 251-257 (1937).

Some notes on *Papilio*, Pieridae and Satyridae. Includes *Eteona tisiphone* ab. n. *nigra*, São Paulo.

38. Revisão do gênero *Pseudopieris* G. & S. Pages 25-31, 2 pls., 2 figs. in Livro jubilar Prof. Travassos. Rio de Janeiro (1938).

Extensive synonymies and discussions of variation.

39. Uma nova espécie do gênero *Iphiclides*. Pages 33-35, 3 figs. in Livro jubilar Prof. Travassos. Rio de Janeiro (1938).

Iphiclides travassosi, n. sp., Distrito Federal, Rio de Janeiro.

40. Dois novos generos da sub-familia "Ithomiinae." Brasil-Medico 52: 412. (1938).

Epityches, n. gen., genotype *Tritonia eupompe* Geyer; *Garsauritis*, n. gen., genotype *Ceratinia xanthestela* (sic!) Bates [misspelling of *xanthostola*].

41. Um novo genero da sub-familia Danainae e um novo synonymo para o genero *Anosia* Hübn. (Lep. Danaidae.) Nota previa. Campo (Rio de Janeiro) 9: 41 (1938).

Diogas, n. gen., genotype *Papilio erippus* Cramer. *Panlymnas* Bryk = *Anosia* Huebner.

42. Nota suplementar (sic!) a "Revisão das *Terias* Americanas." (Lep. Pieridae). Mem. Inst. Oswaldo Cruz (Rio de Janeiro) 33: 231-248. 3 pls. (1938).

Errata, added synonymies and added names for items 31 and 32.

43. Estudo sobre tres gêneros da sub-familia Ithomiinae. (Lepid. Rhop.). Mem. Inst. Oswaldo Cruz (Rio de Janeiro) 33: 381-394. 3 pls. (1938).

Synonymies and discussions of species in *Placidula* d'Alm., *Garsauritis* d'Alm., and *Epityches* d'Alm. Life history notes on *P. euryanassa* (Felder) and *E. eupompe* (Geyer).

44. Revisão do genero *Anteos* Hubn. (Lepid. Pieridae). Mem. Inst. Oswaldo Cruz (Rio de Janeiro) 33: 567-579. 3 pls. (1938).

Very extensive synonymies of each name. Analysis of forms known to d'Almeida.

45. Contribution à l'étude des Mechanitidae. (Lep. Rhopalocera, Danaidea) 1^{re} Note. Lambillionea 39: 78–81 (1939).
Several synonymies. *Ithomia lichyi*, n. n. for *Ithomia drymo pellucida* Zikan (not Weymer).
46. Revisão do género *Appias* (subgen. *Glutophrissa* Butl.) (Lepidoptera). Bol. Biol. (N.S.) (São Paulo) 4: 50–66. 8 figs., 2 pls. (1939).
A. drusilla punctifera n. n. for *Tachyris molpadia* Dewitz, 1877 (not Huebner, 1823), Porto Rico. Extensive synonymies. Life history of *A. drusilla drusilla*.
47. Revisão das espécies americanas da superfamilia Danaoidea (Lepid.: Pieridae [sic!]) Parte I—Familia Danaidae, subfam. Danainae, et Parte 2—subfam. Lycoreinae. Mem. Inst. Oswaldo Cruz (Rio de Janeiro) 34: 1–114. 30 pls. (1939).
Very extensive synonymies and considerable life history work reported: *Anasia gillipus gillipus*; *Diogas erippus*; *Lycorea ceres halia*. Anetiini, new tribe.
48. XI—Lepidópteros Ropalóceros. Bol. Biol. (N.S.) (São Paulo) 4: 268. (1939).
Synopsis of the material collected on a trip to Mato Grosso.
49. Contribuição ao estudo dos Mechanitidae. (Lep. Rhopalocera). Segunda nota. Rev. Ent. (Rio de Janeiro) 10: 277–281 (1939).
Rhodussa, n. gen., genotype *Ceratinia pamina* Haensch; *Hypothyris poemne*, n. sp., Cachoeiro do Breu, Rio Cuminá, Pará.
50. Revisão do género *Aphrissa* Butl. (Lepid. Pieridae). Bol. Biol. (N.S.) (São Paulo) 4: 423–443. 4 pls. (1939).
A. statira cubana (Mac Bean mss.) n. ssp., Cuba. Extensive synonymies.
51. Livro Jubilar do Prof. Dr. Embrik Strand. Rev. Ent. (Pequenas comunicações) (Rio de Janeiro) 10: 480 (1939).
Announces publication of the fifth and final volume of this festschrift.
52. Revisão do género *Phoebis* Hübn. (Lepidopt. Pieridae). Rev. Mus. Paulista 34:—Arq. Zool. Est. São Paulo 1: 67–152. 12 pls. (1940).
Extended synonymies, analysis of variation and life histories of three species in Rio de Janeiro: *Sennae*, *argante* and *philea*.
53. Contribuição ao estudo dos Mechanitidae. (Lep. Rhopalocera). Terceira Nota. Rev. Ent. (Rio de Janeiro) 11: 758–766. 17 figs., 2 pls. (1940).
Czakia Kremky, 1925, junior synonym of *Melinaea* Hübn., 1816; *Gelotophye*, n. gen., genotype *Thyridia mystica* Zikan; *Ithomia neivae*, n. sp., Xapury, Terr. Acre; *Ithomia zikani*, n. sp., Calado, upper Rio Doce, Minas Gerais; *Ithomia oiticicaí*, n. sp., Xapury, Terr. Acre.
54. Algumas observações sobre a fauna de Lepidopteros da América. Rev. Mus. Paulista 35:—Arq. Zool. Est. São Paulo 2: 299–318. 2 pls. (1941).
Notes on Pieridae and Nymphalidae. Among other things makes the new combination *Vanessa virginiensis iole* (Cramer) for Antillean specimens and *V. virginiensis braziliensis* (Moore) for Brazilian specimens. *Marpesia furcula* (Fabr., 1793) for *Papilio iole* Drury, 1782, not Cramer, 1775.
55. Uma nova subespécie de *Iphiclides telesilaus* (Felder, 1864). Rev. Mus. Paulista 35:—Arq. Zool. Est. São Paulo 2: 319–320. 1 pl. (1941).
Iphiclides telesilaus salobrensis, n. ssp., Salôbra, southern Mato Grosso.
56. Contribuição para o conhecimento da biologia do *Phyciodes hermas* (Hew., 1864). (Lepidoptera, Nymphalidae). Rev. Mus. Paulista 35:—Arq. Zool. Est. São Paulo 2: 321–324. 1 pl. (1941).
Complete life history.
57. Contribuição ao estudo dos Mechanitidae. (Lep. Rhopalocera). (4^a nota). Pap. Avuls. Dept. Zool. São Paulo 1(12): 79–85. 8 figs. (1941).

Extended discussion of *Rhodussa* d'Alm. Three new tribes proposed: Thyridiini, Dircennini, Godyridini.

58. [d'Almeida & R. M. Fox.] A revision of the genus *Sais* Hübner. Reading Public Mus. Art Gallery, Sci. Publ. (Reading, Pa.) 3. 5 p., 1 pl. (1941).
59. [in Lauro Travassos.] Relatório da terceira excursão a zona da Estrada de Ferro Noroeste do Brasil realizada em fevereiro e março de 1940. Mem. Inst. Oswaldo Cruz (Rio de Janeiro) 35: 607-696. 9 pls.
Pp. 645-641, Rhopalocera and Heterocera listed from a trip to Mato Grosso.
60. Ligeiras notas sobre alguns papilionídeos americanos. (Lép. Rhop.). Arq. Mus. Paranaense (Curitiba) 2: 29-34 (1942).
Battus (*Parides*) *orophobus*, n. n., for *Papilio ascanius* Cramer, 1775, not Sparrman, 1769¹. *Iphiclidea travassosi* d'Alm. (= *I. agathosilaus* Zikan); *I. aguiari* d'Alm. (= *I. aristosilaus* Zikan).
61. Alguns tipos de gêneros da ordem Lepidoptera. 1ª nota: Rhopalocera, fam. Mechanitididae. Pap. Avuls. Dept. Zool. São Paulo 2: 179-196 (1942).
Mechanitididae n. n. for Mechanitidae. Genotypes noted for 75 generic names assigned to the family. *Greta* Hemming, 1934, and *Nereis* Huebner, [1806], discussed at length.
62. Alguns tipos de gêneros da ordem Lepidoptera. 2ª nota: Rhopalocera, fam. Pierididae. Pap. Avuls. Dept. Zool. São Paulo 3: 73-106 (1943).
Pierididae n. n. for Pieridae. Genotypes noted for 172 generic names assigned to the family. *Mancipium* Huebner [1806] discussed at length.
63. Algumas observações sobre o *Actinote morio* Oberthuer, 1917. (Lep. Heliconiidae, Acraeinae). Pap. Avuls. Dept. Zool. São Paulo 3: 107-110. 3 figs. (1943).
64. Dois novos Mechanitididae do Brasil. (Lep. Mechanitididae). Pap. Avuls. Dept. Zool. São Paulo 3: 165-166. 1 pl. (1943).
Melinaea clara juruaënsis, n. ssp., Rio Jurua, Amazonas; *Hypoleria parcilimbata*, n. sp., Campos do Jordão, São Paulo, 1200 m.
65. Sobre a nomenclatura de alguns grupos superiores da ordem Lepidoptera. 1ª nota: Superfamílias Castanioidea Hepialoidea, Saturnioidea e Stygioidea. Pap. Avuls. Dept. Zool. São Paulo 3: 237-256 (1943).
Types set for the superfamilies, families and tribes within the boundaries set by the title. Rhescyntinae, n. subfam., type *Rhescyntis hippodamia* (Cramer), 1779, in the family Adelocephalidae Burmeister, 1878; Stygioidea, n. superfam., type is *Stygia australes* Latreille, 1803, substituted for *Cossoidea* Mosher, 1916; Stygiinae, n. subfam., type *Stygia australes* Latreille. [NB. Rhescyntinae d'Alm. is a homonym of Rhescyntinae Schuessler, 1936.]
66. Alguns tipos de gêneros da ordem Lepidoptera. 3ª nota: Heterocera, fam. Saturniidae (Gêneros americanos) Arq. Mus. Paranaense (Curitiba) 3: 123-130 (1943).
Types set for 22 generic names in the family. An extended discussion of *Eudaemonia* Huebner, 1819.
67. Sobre a nomenclature de alguns grupos superiores da ordem Lepidoptera. 2ª nota: Famílias Lasiocampidae, Lymantriidae, Mimallonidae e Uranidae e superfamília Arctioidea. Arq. Mus. Paranaense (Curitiba) 3: 131-143 (1943).
Types set for 73 superfamilies, families, subfamilies and tribes. No new names proposed.
68. Alguns tipos de gêneros da ordem Lepidoptera. Quinta nota: Heterocera,

¹ "Sparman, 1769" is not listed in H. A. Hagen, Bibliotheca Entomologica, Vol. 2. Leipzig (1863).

Fam. Hemileucidae. Bol. Mus. Nac. (N.S.), Zool. No. 7 (Rio de Janeiro). 10 p. (1943).

Types set for 46 generic names.

69. Alguns tipos de gêneros da ordem Lepidoptera. Quarta nota: Heterocera, Fam. Mimallonidae. Bol. Mus. Nac. (N.S.) Zool. No. 10 (Rio de Janeiro). 6 p. (1943).

Types set for 32 generic names.

70. Nota suplementar à "Revisão das espécies Americanas da superfamília Danaoidea." Pap. Avuls. Dept. Zool. São Paulo 4: 37-70. 3 pls. (1944).

Considerable additions to the synonymies. Forbes' (1939, 1940) and Clark's (1944) names added. *A. eresimus ares* "spec. nov.," nom. nud.?

71. Estudos biológicos sobre alguns Lepidópteros do Brasil. Arq. Zool. Est. São Paulo 4: 33-72. 3 pls. (1944).

Life histories, some complete, others partial, for: *Dismorphia astynome*, *Dismorphia psamathe*, *Battus (Parides) bunichus*, *Macclungia salonina*, *Brassolis astyra*, *Dione juno*, *Anartia jatrophae*, *Goniurus undulatus*, *G. proteus*, *Pachylia syces*, *Phlegethontius rustica*, *Citheronia laocoon*, *Automeris melanops*, *A. aurantiaca* and *A. incisa*.

72. Sobre a nomenclatura de alguns grupos superiores da ordem Lepidoptera. 3ª nota: Famílias Lemoniidae, Megalopygidae e superfamília Eucleoidea. Pap. Avuls. Dept. Zool. São Paulo 4: 313-318 (1944).

Types set for superfamilies, families, subfamilies and tribes. No new taxa.

73. Nota suplementar à "Revisão do gênero *Phoebis* Huebner." Bol. Mus. Nac. (N.S.), Zool. No. 27 (Rio de Janeiro). 16 p. (1944).

Additional synonymy, errata and a few notes.

74. Segunda nota suplementar à "Revisão das *Terias* Americanas." Arq. Zool. Estado São Paulo 4: 73-94. 1 pl. (1944).

Corrections, augmented synonymies and a few notes. Neotypes set for *nicippe*, *nise*, *phiale*, *albula* and *agare* of Cramer, and *arbela* Geyer.

75. Algumas notas sobre a fauna de Lepidópteros de Monte Alegre. Pap. Avuls. Dept. Zool. São Paulo 6: 21-28 (1944).

A briefly annotated list of 37 species of butterflies and 18 of moths.

76. Revisão do gênero *Xanthocleis* Boisd., 1870. Arq. Zool. Est. São Paulo 4: 97-112. 3 pls. (1945).

Extensive synonymies and discussion. No new taxa.

77. Nota suplementar aos nossos trabalhos sobre os gêneros *Pseudopieris*, *Anteos*, *Appias* e *Aphrissa*. Pap. Avuls. Dept. Zool. São Paulo 6: 225-240. 1 fig. (1945).

Neotypes are designated for *Anteos menippe* Huebner and *Appias drusilla* Cramer. These do not fulfill ICZN requirements. Additional synonymies.

78. Alguns tipos de gêneros da ordem Lepidoptera. 6ª nota: Heterocera, Fam. Dalcerae Dyar. Pap. Avuls. Dept. Zool. São Paulo 5: 193-196 (1945).

Types are set for 13 generic names. No new taxa.

79. Novos Ithomiidae da fauna Brasileira. (Lepidoptera, Rhopalocera.) Bol. Mus. Nac. (N.S.), Zoologia No. 39 (Rio de Janeiro). 13 p., 3 pls. (1945).

Hypothesis niphias, n. sp., Rio Verde, Mato-Grosso; *H. daphnis*, n. sp., Rio Jamari, Mato-Grosso; *H. daphnoides*, n. sp., Monte Cristo, Rio Tapajós; *H. mayi*, n. sp., Altamira, Rio Xingu; *H. ninyas*, n. sp., Rio Verde, Mato-Grosso; *H. iberina*, n. sp., Rio Verde, Mato-Grosso; *H. colophonia*, n. sp., Alto Rio Branco, Amazonas; *H. fenestella nonia*, n. ssp. Alto Juruá; *Rhodussa cantabrica nundina*, n. ssp., Cachoeira do Samuel, Rio Jamari, Terr. Guaporé; *Garsauritis xanthostola bellatula*, n. ssp., São Carlos, E.F.M.-M, Mato-Grosso; *Hyposcada cynara*, n. sp., Manicoré, Rio Madeira; *Melinaea marsaeus pothete*, n. ssp., Rio Verde, Mato-Grosso.

80. Novo nome paro o gênero "Vila" Kirby, 1781 (*sic*). Rev. "Agron." (Rio de Janeiro) 4: 4 (1946). (N.B. The journal part is dated "Julho e Setembro, 1945.")
- Vila* Kirby, 1871, is considered a homonym of *Villa* Lioy, 1864, (Diptera). *Lonia* is proposed as the new name for *Vila* Kirby.
81. [d'Almeida and Oiticica Jr.] An opinion, placed before the International Commission on Zoological Nomenclature, on the status of trinomial combinations by Hübner. Rev. "Agron." (Rio de Janeiro) 4: 25-27 (1946). (See note, item 79.)
- An argument against accepting the first or second names of Huebnerian trinomials as generic or sub-generic.
82. Ligeiras notas sobre Ithomiidae da America do Sul. Anal. Inst. Biol. (Mexico) 20: 393-397. 3 figs. (1949 [1950]).
- Mechanitis elisa acreana*, n. ssp., Xapuri, Terr. Acre; *Dircenna acreana*, n. sp., Xapuri, Terr. Acre. Notes on *Athesis clearista colombiensis* Kaye, 1918 and *Hypothyris fenella* (Hewitson, 1867).
83. Nota retificativa e adicional sobre alguns tipos de gêneros e sobre a nomenclatura de alguns grupos superiores publicados por nós em 1942, 1943 e 1944. Rev. Ent. (Rio de Janeiro) 21: 223-224 (1950).
- Corrects several errors in items 61, 62, 66, 67, 69 and 72.
84. Algumas considerações sobre os gêneros *Mechanitis* Fabr. e *Melinaea* Huebn. (Lep. Ithomiidae). Bol. Mus. Nac. (N.S.), Zool. No. 100 (Rio de Janeiro). 27 p., 5 pls. (1951).
- A discussion of the material in the National Museum (mostly collected by Eduardo May) and descriptions of these new taxa: *Mechanitis egaënsis obumbata*, n. ssp., Alto Rio Juruá, Terr. Acre; *M. travassosi*, n. sp., Terr. Acre; *M. oiticica*, n. sp., Óbidos, Pará; *M. fallax pothetoides*, n. ssp., Rio Verde, Mato-Grosso; *M. foxi*, n. sp., Alto Rio Juruá, Terr. Acre; also, *Melinaea mayi*, n. sp., Alto Rio Juruá, Terr. Acre; *M. acreana*, n. sp., Alto Rio Juruá, Terr. Acre; *M. madeira aequatoriensis*, n. ssp., Ecuador; and *M. hicetas eryx*, n. ssp., Alto Rio Juruá, Terr. Acre; *M. maenius* Hewitson, variety.
85. Ligeiras observações sobre o gênero *Cithaerias* Hübner 1819. (Lep. Satyridae). Arq. Zool. Est. São Paulo 7: 493-505. 2 pls. (1951).
- General and specific discussions, synonymies and these new taxa: *Cithaerias similigena*, n. sp., São Joaquim, Rio Içana, Rio Negro, Amazonas; *C. juruaënsis*, n. sp., Porto Walter, Alto Rio Juruá, Terr. Acre; *Dulcedo*, n. gen., genotype *Haetera polita* Hewitson, 1869. [NB. Chronologically, items 85 and 86, as numbered by d'Almeida, should be transposed.]
86. Uma nova especie de *Actinote* do Sul do Brasil. (Lepidoptera, Heliconiidae; Acraeinae) Arq. Mus. Nac. (Rio de Janeiro) 52: 3-5. 3 figs. (1951).
- Actinote zikani*, n. sp., Boraceia, Salesópolis, São Paulo. [NB. Species name misspelled "mikani" in legend to figure 5.]
87. [d'Almeida and Oiticica, Jr.] The International Commission on Zoological Nomenclature and the name of the Monarch Butterfly. Science 113: 728-729 (1951).
- Agreement with the point of view of Field, Clarke and Franclemont (1951) countering Hemming's action.
88. Algumas notas sobre os gêneros *Hypoleria* e *Napeogenes*. Rev. Soc. Entomol. Arg. 15: 190-200. 4 pls. (1951).
- Hypoleria goinana*, n. sp., Campinas, Goiás; *H. jaruensis*, n. sp., Rio Jarú, Mato-Grosso; *H. olerioides*, n. sp., Rio Jamari, Mato-Grosso. *H. brevicula*, n. sp., Fumaya, Amazonas, border of Brazil and Peru; *H. jamariensis*, n.

- sp., Rio Jamari, Mato-Grosso; allotype for *H. fausta*, Upper Rio Juruá, Terr. Acre; *H. chresta*, n. sp., Jauareté, Rio Negro, Amazonas; *Napeogenes jamariensis*, n. sp., Rio Jamari, Mato-Grosso; *N. gryne*, n. sp., "Amazonas."
89. Duas novas subspécies de Rhopalocera da América. (Lep. Satyridae e Nymphalidae). Bol. Mus. Nac. (N.S.), Zool. No. 114 (Rio de Janeiro). 3 p., 2 figs. (1952).
- Dynamine mylitta mexicana*, n. ssp., Presidio, Mexico; *Euptychia ocirrhoë interjecta*, n. ssp., Três Rios, Jacarépaguá, Rio de Janeiro. *Euptychia summandosa* Gosse, 1880 (= *E. hesione* f. *subobscura* Weymer, 1910).
90. Novas espécies Sul-Americanas da família Ithomiidae. (Lep. Rhopalocera). Bol. Mus. Nac. (N.S.), Zool. No. 115 (Rio de Janeiro). 4 p., 2 pls. (1952).
- Hypothyris violantilla*, n. sp., Salôbre, southern Mato-Grosso; *Ithomia arduinna*, n. sp., Chapare, Bolivia; *Hyposcada olerioides*, n. sp., Yungas de Palmar, Bolivia. *Sais rosalia badia* Haensch is not a synonym of *rosalinde* Weymer.
91. Uma nova espécie do gênero *Rhodussa* D'Almeida, 1939. (Lepidoptera, Hiomiidae). Rev. Brasil. Ent. 1: 113–114. 1 fig. (1954).
- Rhodussa carvalhoi*, n. sp., Maracanaí, Rio Paru de Leste, northern Pará.
92. Algumas notas sobre Rhopalocera do Brasil. (Lep.). Rev. Brasil. Ent. 5: 197–202. 4 figs. (1956).
- Synonymy of Zophan names among Pieridae and Cithaerias; and description of *Brassolis sophorae dinizi*, n. ssp., João Pessoa, Paraíba, (ex larva).
93. Notas sinonímicas sobre Ithomiidae. (Lepidoptera, Rhopalocera). Bol. Mus. Nac. (N.S.), Zool. No. 143 (Rio de Janeiro). 18 p. 21 figs. (1956).
- Lectotypes are established and figured for numerous Zikan taxa. *Ceratinia nise zikani*, n. ssp., Utinga, Belém, Pará.
94. Breves notas sobre o gênero *Rothschildia* Grote, 1897. (Lepidoptera, Saturniidae). Bol. Mus. Nac. (N.S.), Zool. No. 171 (Rio de Janeiro). 47 p., 5 figs. (1957).
- Extensive synonymies (spoiled by some typographical errors); life histories, partial or complete, for: *erycina belus* (Maasen & Weymer), *arethusia* (Walker), *betis melini* Bryk and *aurota speculifer* (Walker).
95. Espécies e subespécies novas de Ithomiidae. (Lepidoptera, Rhopalocera). Bol. Mus. Nac. (N.S.), Zool. No. 173 (Rio de Janeiro). 17 p., 13 figs. (1958).
- Napeogenes paruensis*, n. sp., Maracanaí, Rio Paru de Leste, Pará; *N. sylphis acreana*, n. ssp., Seringal Oriente, nr. Vila Taumaturgo, Rio Juruá, Terr. Acre. *Hypothyris honesta acreana*, n. ssp., Seringal Oriente, *H.* [misspelled *Hypothoris*!] *meterus arpi*, n. ssp., Itaituba, Tapajóz, Pará. *Callithomia travassosi*, n. sp., Dumba, Rio Araguaia, Mato-Grosso; *C. juruaënsis*, n. sp., Seringal Oriente, nr. Vila Taumaturgo, Rio Juruá, Terr. Acre; *Hypoleria plisthenes*, n. sp., Carmo, Rio Claro, Minas Gerais; *H. novaesi*, n. sp., Seringal Oriente; *H. mulviana*, n. sp., Fordlândia, Rio Tapajóz, Pará; *H. exornata* Haensch, female described. *Heterosais edessa covella* n. ssp., Cojimies, Manabi, Ecuador.
96. Ligeiras notas sobre algumas *Actinote* do sudeste do Brasil. (Lepidoptera, Rhopalocera). Bol. Mus. Nac. (N.S.), Zool. No. 178 (Rio de Janeiro). 7 p., 1 fig. (1958).
- Corrected synonymies for *A. pyrrha* (Fabr.) and *A. melanisans* Oberthür. *A. aequatoria*-group is discussed.
97. Estudos sobre algumas espécies da família Ithomiidae. (Lepidoptera, Rhopalocera). Bol. Mus. Nac. (N.S.), Zool. No. 215 (Rio de Janeiro). 31 p., 10 pls. (1960).

Corrections of synonymies on the basis of several Bates' "syntypes" and of photographs of Schaus' types. The plates illustrate these specimens. N.B. plates 1 and 3, and 9 and 10 are reversed in position.

98. Terceira nota suplementar à nossa revisão do gênero *Eurema* Hübner, 1819. (Lepidoptera, Pieridae). Rev. Brasil. Ent. 9: 81-108 (1960).

The extensive bibliographies of the original revision (items 31, 32, 42, & 74 above) are brought up to date through 1959. The validity of the neotypes for *nise* and *phiale* by Klots and Heineman is questioned (p. 96-97). D'Almeida (item 74) set neotypes for these in 1944.

99. Descrição de verdadeira fêmea de *Anthoptus epictetus* (Fabricius, 1793). (Lepidoptera, Hesperiiidae, Hesperinae). Rev. Brasil. Ent. 10: 33-35. 2 figs. (1961).

Both sexes are figured.

100. Descrição de duas novas espécies de Ithomiidae do gênero *Oleria*. Bol. Mus. Nac. (N.S.), Zool. No. 299 (Rio de Janeiro). 4 p., 2 figs. (1962).

O. machadoi, n. sp., Serra do Navio, Terr. Amapá, and *similigena*, n. sp., Serra do Navio, Terr. Amapá.

101. Page 305 in F. Hemming, Proposed use of the plenary powers to validate the spelling of "Pieridae" as against the spelling "Pierididae" as the family-group name based on the generic name "Pieris" Schrank, 1801 (Class Insecta, Order Lepidoptera). Bull. Zool. Nomen. 12 (1936).

D'Almeida favors the grammatically correct spelling Pierididae.

102. Novos Ithomiidae brasileiros. Bol. Mus. Nac. (N.S.), Zool. No. 252 (Rio de Janeiro). 6 p., 4 figs. (1964).

Ceratinia giparanaensis, n. sp., Vila Rondônia, Rio Giparaná, Terr. Rondônia; *Oleria itacoaiensis*, n. sp. Rio Itacoai, Amazonas; *O. pitonia*, n. sp., Benjamin Constant, Amazonas; *O. placidina*, n. sp., Benjamin Constant, Amazonas.

103. Catálogo dos Papilionidae americanos. Sociedade Brasileira de Entomologia, São Paulo, 366 p. (1966).

Extensive synonymies of all American taxa in the family. Some notes on Brazilian taxa, some life history information. This brings Rothschild & Jordan (1906) up to date (ca. 1965).

104. [with Olaf H. H. Mielke] Tres espécies novas de "Ithomiidae" Brasileiros. (Lepidoptera). Atas Soc. Biol. (Rio de Janeiro) 11: 71-73. 9 figs. (1967).

Pteronymia dentei, n. sp., Três de Agosto, Município de Conceição da Barra, Espírito Santo. *Episcada zajcivi*, n. sp., Ubajara, Ceará; *E. vitrea*, n. sp., Alto da Serra, Petrópolis, Rio de Janeiro.

105. Nova espécie de Papilionidae: *Battus (Parides) castilhoi* sp. n. Rev. Brasil. Ent. 12: 89-90. 1 pl. (1967).

Type locality is Castilho, Rio Paraná, São Paulo.

- 106.* Algumas considerações sobre Arctiidae Brasileiros, com as descrições de duas espécies novas (Lepidoptera—Heterocera). Rev. Soc. Entomol. Arg. 30: 3-7. 13 figs. (1967).

Hyperandra cezari n. sp., Serra do Navio, Amapá; *Rhipha barrosi* n. sp., Serra do Navio, Amapá; *Cresera annulata* Schaus, 1894 is not a synonym of *C. ilus* (Cramer, 1776).

107. [with K. S. Brown, Jr.] The Ithomiinae of Brazil. (Lepidoptera: Nymphalidae). II. A new genus and species of Ithomiinae with comments on the tribe Dircennini d'Almeida. Trans. Amer. Entomol. Soc. 96: 1-17. 17 figs., 1 pl., 1 map (1970).

Ceraticada, n. gen., genotype *Nereis Vitrea doto* Hübner, 1807; *C. canaria*, n. sp., 9 km. s. Pedro Canário (formerly Morro d'Anta), Município Conceição da Barra, Espírito Santo. Life history is recorded.

The following posthumous publications were edited by Prof. Olaf H. H. Mielke:

108. Notas sobre Pieridae americanos (Lepidoptera). Acta Biol. Paranaense (Curitiba) 1: 51-72 (1972).
Brings up to date (ca. 1966) synonymies for: *Anteos* (see items 44, 77); *Aphrissa* (see items 50, 77); *Appius* (see items 46, 77); *Eurema* (see item 98); *Phoebis* (see items 53, 73); *Pseudopieris* (see items 38, 77).
- 109.* Notas sobre Ithomiidae e Danaidae americanos (Lepidoptera). Atas Soc. Biol. (Rio de Janeiro) 16: 73-81.
Supplements earlier work on *Xanthocleis* (Ithom.) (item 76) and brings up to date (ca. 1966) the synonymy of Danaidae (items 47, 70).
- 110.* Observações sobre Rhopalocera do Brasil das famílias Ithomiidae e Hesperidae (Lepidoptera) (in preparation).
The females of *Oleria machadoi* and *semiligena* (item 99) are described and allotypes designated. *Chrysopspectrum cuminaensis* n. sp. is described from Cachoeira do Breu, Rio Cuminá, Pará.
- 111.* Biologia de duas espécies de Saturnioidea (Lepidoptera). Atas Soc. Biol. (Rio de Janeiro) (in press August 1973).
Life histories of *Rothschildia hesperus* (Linne, 1758) and *Copiopteryx montei* Gagarin, 1933.

The following article was left incomplete and is being completed by Prof. Olaf H. H. Mielke:

- 112.* Catálogo dos Ithomiidae (Lepidoptera) (in preparation). ca. 400 p.
Complete synonymies (to 1965) with comments on Brazilian species and some life histories.

D'Almeida had prepared the manuscript for a book about the butterflies and moths of Brazil similar to Holland's books. The manuscript is so large that there appears to be very little chance that it will be published.

SEASONAL FORMS OF *ANTHOCHARIS SARA*
(PIERIDAE)

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Interesting field observations by Fred Thorne of an unusually early appearance of the summer form of *Anthocharis sara* Lucas on 14 March 1973 in wild populations near San Diego, California are worthy of immediate publication. His request for data on my rearing of summer form "sara" from ova laid by spring form "reakirtii" points out how important it is for this information to emerge from the seclusion of my entomological notebooks. These 1953–1956 rearing records are not outdated—after all, in their recent book, Emmel & Emmel (1973) cite my 21 year old paper (Evans, 1952b) as evidence of the short pupal period of summer form "sara." That report referred to a 1941 emergence.

Using method I of Masters (1972), I designate these seasonal forms as:

Anthocharis sara Lucas form "sara" (summer brood).

Anthocharis sara Lucas form "reakirtii" (spring brood).

It might have been better if a name other than the specific name had been given to the summer form; however, *sara* apparently has always referred to this large form with a lightly speckled under side.

Twenty years of studying, collecting and rearing members of a wild population of *A. sara* in La Tuna Canyon, elev. 1,200 ft., Verdugo Mts., Los Angeles County, Calif. where my backyard was one of the main orange-tip flyways (Evans, 1952a, 1955), proved to me that this species did not have a standard spring and summer brood set-up. Specimens of summer form "sara" are produced from that small portion of the offspring of a female "reakirtii" which spend only two to three weeks in the pupal stage, while other siblings will emerge as spring form "reakirtii" after remaining as pupae until the next spring, or even the second or third spring. Flying in springtime with these "reakirtii" offspring of "reakirtii" will be "reakirtii" from a second source—ova laid by summer form "sara" during April, May or June of any of the three preceding years. Differing weather conditions cause variations in time and duration of flight periods from year to year. If spring rainfall ceases too soon after the "reakirtii" flight, summer form "sara" will not even appear that year. If several rainless weeks during late March and early April are followed by soaking rains in late April and early May, a brood of summer form "sara" will emerge the last part of May and the first week of June.

At this point, rearing data which influenced my opinions should be given. The total number of specimens reared can be listed under four categories:

1a. Spring form "reakirtii" which are the F_1 generation of "reakirtii" females, and which emerge first, second or third spring after pupation. 1950–1959, 350 reared from ova laid by 25 females (some wild, others emerging and mating in rearing cages).

1b. Summer form "sara" which are F_1 of "reakirtii" females, and which emerge 16–21 days after pupation. 1955, one male 27 May. 1956, one female 6 May.

2a. Spring form "reakirtii" which are F_1 of summer form "sara," and which emerge first, second, or third spring after pupation. 1952–1956, 28 specimens from ova of 8 wild "sara" females.

2b. One male of intermediate maculation emerged 15 March 1953 as F_1 of a wild "sara" female after 9 months as a pupa. The under side of the hind wing of this male has a "sara" pattern with gray specks of very small size and also fewer in number than in "reakirtii," while the hind wing upper side has the marginal black spots at the ends of the veins almost as large as in "reakirtii."

The first three categories enumerated above can be explained logically. The one example under listing 2b adds confusion to the whole situation, especially with a sister of this "sara"-like male emerging the following day as a genuine spring form of "reakirtii." Many offspring of summer brood "sara" should be reared to see if more of these pseudo-"sara" would occur. No wild specimens of this sort were ever found.

In an attempt to produce summer form "sara," special rearing methods were tried with larvae whose parents, both spring form "reakirtii," had mated for 30 minutes in the rearing cage on 27 March 1955. The mother was the offspring of a wild yellow female "reakirtii" collected 3 February 1953. The father was offspring of a yellowish "reakirtii" female # 13 caught 25 February 1954. Larvae were placed in white organdy cylinders 3.5 cm in diameter and 7.5 cm long with a circle of the cloth sewed in one end and a thread drawstring attached for closing the opposite end tightly around a stem of foodplant. Each mini-sleeve, with one 4th instar larva inside, was tied around one or two flowering spikes of sweet alyssum, *Lobularia maritima* (L.) Desv. The plants were growing next to the top of a rock and cement wall along the border of a flower bed. In 1955, the spring rains seemed to be over in early March, but 41 days later rain fell steadily for 13 hours on 21 April. The larvae were installed in the sleeves in time to receive 3 hours of rain on 26 April, 13 hours on

30 April, and 4 hours on 1 May. Some larvae were in prepupal stage during 11 hours of rain on 7 May—one of these produced a male of summer form "sara" on 27 May. Members of the wild population emerged simultaneously, a fresh male being caught each day on 26, 27, 28 and 29 May. The confined larvae probably grew more slowly than the wild ones, which could have matured from ova of wild "reakirtii" laid as late as 17 April when the last female of the spring form was seen that year. In addition to the four May males, only two other wild "sara" were seen in 1955: one male and one female on 19 April.

Larvae in sleeves were established on the plants again in 1956 when 38 hours of rain during four April days followed a rainless March. A female of form "sara" emerged 6 May, the same day that a yellow wild female flew through the yard. For the entire "sara" season (22 April to 5 June), 5 wild males and 5 wild females were observed or captured. Between 7 May and 18 May and again between 20 May and 4 June there were gaps in the flight period.

In both 1955 and 1956, the occurrence of a second period of spring rainfall caused the emergence of a small number of summer form "sara" in the wild population as well as among reared individuals exposed to the rainfall. Many pupae of the wild population must have initiated diapause to await springtime emergence as form "reakirtii," which is what occurred with twelve pupae in organandy sleeves—four of these which were brothers or sisters of the reared male "sara" emerged as "reakirtii" in February and March 1956.

In southern California, rains in April and May are considered unusual; in almost six out of ten years, there is no rain after the end of March. Several recent years have also been short of rainfall in fall and winter. In contrast, early 1973 was unusually wet in San Diego County as reported in letters from Fred Thorne, with frequent long periods of steady rainfall in January, February and March.

During the few sunny days in late January, throughout February, and in early March, Thorne found a few *Anthocharis sara* spring form "reakirtii" flying at several locations. Then came a big surprise on 14 and 15 March when he captured a female and male of summer form "sara"—the first March appearance of this form during his many years as a lepidopterist! At four different localities near San Diego during the last half of March 1973, he found a total of eight specimens of the summer form. At Lower Otay Lake, where a male "sara" was flying 15 March, no more were seen in late March or the first week of April; however, on 12 April, Thorne found summer form "sara" flying all over the area and collected 21 males and 5 females. Thorne's observations on the earliest

“sara” specimens seems to indicate a maturation period of five or six weeks from oviposition by spring form “reakirtii” to emergence.

CONCLUSIONS

Two factors prove that the production of summer form “sara” is actually triggered during the larval stage: (1) The reared male received rainfall during the last two larval instars but none as a pupa. (2) Because size of adults is determined by size of pupae, the large size of wild “sara” adults indicates that larger growth occurred in the larval stage thus resulting in larger pupae.

Genetically identical larvae respond differently to the same conditions of rain and sunshine—from the same batch of ova, some larvae transform into short duration “sara”-producing pupae, while others form diapausing “reakirtii”-producing pupae. Perhaps micro-climatic conditions are a factor—during rainy periods, the larva on top of a stem gets wetter than one clinging to the under side of a stem. Differing temperatures between shady and sunny side of a stem on clear days might have an influence.

In an earlier paper (Evans, 1952b) the possibility was considered of two different kinds of form “reakirtii” which could be distinguished by the amount of yellow on the apex of the forewing under side. Additional rearing since then proved this to have no diagnostic value. The possibility of two genetic strains of the species *sara*, one of which never produces summer form “sara,” cannot be dismissed.

It is hoped that this paper will arouse interest of many lepidopterists in rearing *Anthocharis sara* to help clarify various problems.

Most of my *Anthocharis* specimens are now in the Allyn Museum of Entomology. The reared “sara” male and a few “reakirtii” are in the Yale University collection.

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THE HESPERIOIDEA OF THE SOUTH COASTAL AREA
OF SOUTH CAROLINA

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South Carolina has much to offer the lepidopterists. There are fewer records, especially for recent years, from South Carolina than from any other state in the southeastern United States. This paper covers only the southern coastal counties of South Carolina and the skippers of that area. The included counties are from south to north: Jasper, Beaufort, Colleton, Charleston, Dorchester and Berkeley; this is the area south of the Santee River.

There exists but one paper (Sharpe, 1914) on the butterflies of this area of South Carolina. Sharpe (1914) included but 7 species of skippers, all taken in Charleston County. This paper deals with over 50 species of Hesperioidea. Many of the species were collected in this area by earlier collectors, but this paper represents the first documentation of their occurrence in the defined region. Due to this lack of documentation, nearly all species included herein represent new county records and range extensions. Species which are new state records are followed by an asterisk (*). All records are those of the author except where otherwise noted.

Megathymus yuccae (Boisduval & Le Conte). This species is well established in Charleston County. The largest colony is on Edisto Island with adults on the wing in March–April.

Panoquina panoquin (Scudder). Charleston, Beaufort and Jasper Counties, in and around salt marshes. A good flower visitor, most common at Hunting Island in Beaufort County during August; flies from April–September.

Panoquina ocola (Edwards). Berkeley, Charleston and Beaufort Counties. Flight period, May–September, with peak flight in August. Found in varied habitat: in Beaufort County around salt marshes with *P. panoquin*; in Berkeley County it occurs in pine woods, along roads and railroad tracks.

Calpodex ethluis (Stoll). Charleston County, July–August. Usually uncommon around host plant, canna.

Oligoria maculata (Edwards).* Berkeley, Colleton and Charleston Counties. Found to be rather local in Berkeley County during August–September. Elsewhere it flies during May–June and again in August–September.

Lerodea eufala (Edwards). Found in all the counties covered by this paper. It may be very common in the fall, but is on the wing from May–September.

Amblyscirtes aesculapius (Fabricius). Charleston, Beaufort, Dorchester, Berkeley and Colleton Counties, rather rare with scattered dates of capture from April–August.

Amblyscirtes reversa (Jones).* Berkeley County is the only area where *reversa* has been found, and then only at one locality. It is rare and has been taken during July–August. A pair (♂, April 18, 1971; ♀, May 18, 1971) taken at the same

locality may prove to be *Amblyscirtes carolina* (Skinner) because they seem to key out with Freeman's (1973) description.

Amblyscirtes alternata (Grote & Robinson).* Berkeley County, one mi. W of the junction of I-26 and Hwy. 17-A; rare and local during April-May. Dr. R. B. Dominick has found this species at the Wedge Plantation in Charleston County where it is also rare.

Atrytonopsis loammi (Whitney).* In Berkeley County this species has been found only at the junction of I-26 and Hwy. 17-A locality where it is uncommon. It has been taken in April, July and August.

Euphyes palatka (Edwards).* Berkeley and Jasper Counties. A fresh female was taken at the Naval Weapons Station in Berkeley County on May 29, 1972. In Jasper County at the Savannah River Wildlife Refuge, *palatka* is on the wing during May-June and is uncommon.

Euphyes dion (Edwards). *Dion* has been collected in Dorchester, Charleston, Berkeley and Colleton Counties as scattered individuals. Most of the specimens have been taken one mi. N of the Ashepoo River along Hwy. 17 in Colleton County. Dates of capture are May-June and August-September.

Euphyes alabamiae (Lindsey).* This species is known to occur at a very very small sedge-cypress pond surrounded by pine flats one mi. W of the junction of I-26 and Hwy. 17-A in Berkeley County where it flies during September.

Euphyes dukesi (Lindsey).* Charleston and Colleton Counties. First found by Dr. R. B. Dominick at the Wedge Plantation in Charleston County. In Colleton County it is found one mi. N of the Ashepoo River along Hwy. 17. It is usually collected during May-June and is uncommon to rare.

Euphyes berryi (Bell).* S. S. Nicolay took one male in Jasper County along Hwy. 17 some years ago (I do not have the date). In Berkeley County at the small sedge-cypress pond one mi. W of the junction of I-26 and Hwy. 17-A during July-August. The Berkeley County area is the northern most record for this species. Suitable habitat for *berryi* exists along Hwy. 17 in Charleston County, but it has not been found there yet. As far as I have been able to determine, specimens of *berryi* which I collected in the Pensacola area of Florida represent the western most record of this species; July-September 1969.

Euphyes bimacula (Grote & Robinson). Found in Berkeley County at the I-26 and Hwy. 17-A locality during July-August. Usually uncommon flying with *E. berryi*, *E. alabamiae* and *Atrytonopsis loammi*.

Euphyes vestris metacomet (Harris). Berkeley, Dorchester, Charleston, Colleton and Beaufort Counties; generally uncommon from April-September.

Poanes zabulon (Boisduval & Le Conte). In Dorchester County where it is local and uncommon and in Charleston County at the Wedge plantation by R. B. Dominick. Dates of capture have been during April, May and June.

Poanes aaroni howardi (Skinner).* Jasper County at the Savannah River National Wildlife Refuge during May and during August-September, where it is uncommon.

Poanes yehl (Skinner). Dorchester, Berkeley, Charleston and Colleton Counties; uncommon to rare with best collecting in Colleton County one mi. N of the Ashepoo River along Hwy. 17. It flies during May-June and again in September.

Poanes viator zizaniae (Shapiro).* All counties in the southern coastal area except Dorchester; common to abundant around marshes from May-September.

Problema byssus (Edwards).* Beaufort, Charleston, Dorchester and Berkeley Counties; may be common at times especially in the fall brood. Flight period during June and August-September.

Problema bulenta (Boisduval & Le Conte). In Jasper County at the Savannah River Wildlife Refuge where it is not uncommon but difficult to catch as it flies out over the vast swamp during June-August. In Charleston County at the Wedge Plantation by R. B. Dominick, where it is rare.

Atrytone delaware (Edwards). All counties not uncommon, May–August.

Atalopedes campestris (Boisduval). All counties from April–October, however it is never very common.

Pompeius verna sequoyah (H. A. Freeman).^{*} All counties from May–September; at times it is common but usually is uncommon.

Wallengrenia otho (Smith). In all coastal counties usually common, at times abundant, flight period from May–October. This species is highly variable from very light to very dark.

Wallengrenia egeremet (Scudder). This species has been collected in the western part of South Carolina (Pickens County) but it has not yet been found in the southern coastal area.

Polites themistocles (Latreille). Found in all of the coastal counties from June–October, however not very common.

Polites origines (Fabricius). Berkeley, Dorchester, Charleston and Colleton Counties; often flying with *themistocles* but less common, June–September.

Polites vibex (Geyer). All southern coastal counties where it is common everywhere from March–November.

Hylephila phyleus (Drury). All southern coastal counties where it is common from May–November.

Copaodes minima (Edwards). Berkeley and Charleston Counties where it is local but not uncommon when found. It flies during May–June and again in August–September.

Ancyloxypha numitor (Fabricius). Berkeley, Charleston, Jasper and Beaufort Counties. It is often found with *Copaodes minima* and likes to feed on low flowers and dung in wet grasses. Found from April–September, it is usually uncommon, best collected at the Wedge Plantation in Charleston County.

Lerema accius (Smith). All coastal counties, May–September, usually uncommon though wide-spread.

Nastra lherminier (Latreille). Found from April–September in all coastal counties and is often common.

Pholisora catullus (Fabricius). Berkeley, Charleston and Beaufort Counties; not uncommon from July–September.

Pyrgus communis (Grote). All counties very common, March–December.

Erynnis brizo (Boisduval & Le Conte). In Charleston County at the Wedge Plantation and Berkeley County, usually uncommon to rare during April–May.

Erynnis baptisiae (Forbes). Berkeley and Dorchester Counties from April–June, very localized and rare.

Erynnis zarucco (Lucas). March–October in all of the southern coastal counties, rather common.

Erynnis martialis (Scudder). Not recorded from the coastal counties although it is rare and localized at Rocks Pond Camp Ground in Orangeburg County which is close to the Berkeley County line (July 4, 1971).

Erynnis horatius (Scudder & Burgess). All southern coastal counties during April–May and June–July, usually common.

Erynnis juvenalis (Fabricius). Charleston County south of the air force base along Hwy. 642 where it is rare and on the Wedge Plantation where it is common, April.

Staphylus mazans hayhurstii (Edwards). Not recorded from the southern coastal counties although recorded from Rocks Pond Camp Ground in Orangeburg County where it is very local (July 4, 1971).

Thorybes bathyllus (Smith). All southern coastal counties where it is not uncommon. Two broods in May–June and August–September.

Thorybes pylades (Scudder). Berkeley, Charleston and Dorchester Counties rather rare only recorded from April–May.

Thorybes confusus (Bell). Berkeley and Charleston Counties; it may be very common in Berkeley County during April at one mi. W of the junction of I-26 and Hwy. 17-A. Two broods which come out in April and July. The first brood of *T. bathyllus* and the second brood of *T. confusus* may be exactly the same in color and pattern. Based on genitalic dissection it appears that many specimens in collections are mislabeled.

Achalarus lyciades (Geyer). All coastal counties except Jasper, April-May and July-August, generally uncommon.

Antochton cellus (Boisduval & Le Conte). In Dorchester County it is very rare (one ♂ April 29, 1972; one ♀ April 28, 1973) but obviously breeds some where in the area of Hwy. 642 near the Dorchester and Charleston County line.

Urbanus proteus (Linnaeus). All southern coastal counties where it builds up in numbers and becomes common by August. It may be found from April-December.

Epargyreus clarus (Crammer). April-September in all of the southern coastal counties of South Carolina, common.

The southern coastal counties of South Carolina show a distinct Lower Austral and limited Subtropical faunal composition. This is evidenced by those species which are usually associated with Florida or extreme coastal Georgia and which also have been found in the southern coastal region of South Carolina. Not only is this true with the HesperIIDae of these regions i.e., *Euphyes berryi*, *E. palatka*, *Megathymus yuccae*, *Problema byssus*, *Poanes aaroni howardi* and *Atrytonopsis loammi*, but also in other families. The LycaenIDae found in both areas are: *Brephidium isophthalma pseudofoea* (Morrison), *Hemiargus ceraunus antibubastus* (Hübner), *Satyrrium liparops liparops* (Le Conte), *S. calanus calanus* (Hübner) and *S. kingi* (Klots & Clench); the NymphalIDae are: *Heliconius charitonius tuckeri* (Comestock & Brown), *Phyciodes phaon* (Edwards) and *Asterocampa alicia* (Edwards). *Danaus gilippus berenice* (Cramer) (DanaiIDae) and *Lethe appalachia appalachia* (Chermock) and *Euptychia cymela viola* (Maynard) (Satyridae) are also common to both regions.

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HESPERIID NOTES

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The insect described by Dyar in 1904 as *Thorybes mysie* has been referred to in the literature a number of times, but very little is known about it due to lack of material. Very few specimens are known.

Tilden (1949) reviewed much of the literature and illustrated a male topotype and the genitalia.

Lindsey (1921) and Lindsey, Bell & Williams (1931) said of *mysie*, that they did not know this species. It is interesting that Hoffmann (1941) stated (free translation of the Spanish) that *mysie* is found "From Sonora to the mountains of the Central Valley of Mexico. It ranges up to elevations of about 2500 meters or somewhat more." But on the next page he says of *Thorybes valeriana* Ploetz, "I do not know this species."

Evans (1952) synonymized *mysie* Dyar 1904 with *Thorybes valeriana* (Ploetz) 1882, on the basis of a copy of a manuscript figure in the British Museum, and three female specimens in that collection. I have not seen these specimens, but they can scarcely be the insect described by Dyar as *mysie*. Evans was a very careful worker, and he would have noted at once that *mysie* does not fall structurally into *Thorybes* as placed by him in Section 2 of the Pyrginae, which has the palpi upturned, the third segment appressed to the face. *Mysie* falls into Section 3, the palpi more or less porrect, the third segment protruding beyond the second. Moreover, the antennae of *Thorybes* are arcuate or hooked. Those of *mysie* have the apiculus bent at right angles to the club. *Mysie* is structurally similar to *caicus* Herrich-Schaeffer 1869, which Evans placed in the genus *Cogia*. *Caicus* and *mysie* share with members of the genus *Cogia*, the form of the antennal apiculus, and the out-of-line position of the apical hyaline spot in space 6 (the lower, or 4th, apical spot).

However, both *caicus* and *mysie* have the palpi longer than the head as seen from above, and the males lack the hair pencil at the base of the hind wings which is present in *Cogia* and is a distinctive feature of that genus. On the basis of these differences, it seems desirable to retain *caicus* and *mysie* in another genus than *Cogia*.

Godman & Salvin (1894) proposed *Phoedinus* and included *caicus* and *aventinus* (G. & S.). Skinner (1911) included *mysie*, treating *Phoedinus* as a subgenus under *Eudamus*. Lindsey (1921) selected *caicus* as the type-species of *Phoedinus*.

Mabille & Boulet (1919) proposed *Anaperus* to replace *Phoedinus* Godman & Salvin 1894, considered to be a homonym of *Phaedinus* Duponchel 1834, which was used by Guérin-Méneville (1838), but misspelled *Phoedinus*. See Cowan (1970) for a more complete discussion. *Anaperus* is itself a homonym. It was replaced by *Caicella* Hemming in 1934.

But as pointed out by Cowan (loc. cit.), under present rules *Phoedinus* Godman & Salvin 1894 is not a homonym of *Phaedinus* Duponchel 1834, but is a valid genus, and the replacement name *Caicella* Hemming 1934 is not needed, and is junior synonym of *Phoedinus* Godman & Salvin.

It appears that the binomen *Phoedinus mysie* (Dyar) 1904 is valid and should be returned to prior usage.

Lindsey (1921), Skinner & Williams (1924), Lindsey, Bell, & Williams (1931), and Bell (1938), in dealing with the American members of the genus *Ochlodes* Scudder 1872 (*Augiades* auct., nec Hübner 1819), all place both *agricola* Boisduval 1852, and *sylvanoides* 1852 correctly. All, however, fail to associate *nemorum* Boisduval 1852 with *agricola*, but associate it either with *sylvanoides*, or regard it as a distinct species.

Skinner & Williams (op. cit.) note that *agricola* has hyaline spots below the stigma, and a white central line in the stigma, associating *agricola*, *milo* and *verus* correctly. However, they consider *nemorum* a light form of *sylvanoides*.

Lindsey and Lindsey, Bell & Williams, have the same concept of *nemorum* as a light *sylvanoides*-type insect, but both raise *nemorum* to the species level, and this position is taken by Bell (1938). As will appear below, they are correct in realizing the existence of a small, pale *sylvanoides*-like insect in California, but are mistaken in the name they apply to it.

Evans (1955) seems to have been the first to associate *nemorum* with *agricola*, placing it as a subspecies of *agricola*.

In the early 1950's I sent some specimens to Evans for comparison with the Boisduval specimens in the British Museum. The ones I had considered to be *agricola* and *sylvanoides* agreed with the Boisduval type material. The one that was *nemorum* by the Skinner-Williams-Lindsey-Bell concept, proved to agree entirely with the insect named *pratincola* by Boisduval.

Thus it appears that the insect previously considered by most American workers to be *nemorum*, actually is *pratincola* Boisduval 1852. Evans (op. cit.) placed it as a subspecies of *sylvanoides*. Lindsey (1921) placed it as a subspecies of *nemorum*, his concept of *nemorum* being of the insect that is actually *pratincola*.

Pratincola looks like a small pale *sylvanoides*, flying in June. It appears just as *Ochlodes agricola* is becoming worn, and is gone by the time the late-flying *sylvanoides* appears. It is a rather uncommon species, and is likely to be undetected among the numbers of the much more common *agricola*.

Ochlodes pratincola Boisduval 1852 should be restored to rightful position as a valid species. It should be listed after *sylvanoides* and before *agricola*, as No. 79.1 in the dos Passos List.

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POPULATION BIOLOGY AND ADULT BEHAVIOR OF
LYCAENA XANTHOIDES (LYCAENIDAE)

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A mark-release study of *Lycaena xanthoides* Boisduval was carried out in a small field in Berkeley, Alameda County, California from 6–17 July 1969. In addition, adult behavior was studied at nearby Point Richmond, Contra Costa County. This account serves as a comparison to that for *Lycaena arota* Boisduval. (Scott, 1973b). The methods used are those of Scott (1973b).

Mating. *Lycaena xanthoides* is a perching species as is *Lycaena arota* (Scott, 1973b). Males perch on vegetation about a meter above the ground, and dart out at passing insects in search of potential mates. Perching takes place near the larval hosts, *Rumex* spp. (Polygonaceae), along watercourses and in flat fields. Aerial encounters are common between conspecific males as well as between male *Lycaena* and males of other butterflies. In the morning males perch on non-flowering vegetation, but in the afternoon both sexes congregate at flowers, where males perch and court females.

A male will fly after a passing female. The male often hovers over the female, beating his wings with wide amplitude about seven times per second, then lands behind the female and bends his abdomen laterally to copulate. The male rarely flutters while sitting behind the female. Two successful copulations were observed in which the females remained quiescent after landing. Females were unreceptive in most attempted courtships. Unreceptive females when pursued by a male, alight and flap their wings with wide amplitude about five or more times per second until the male departs. This flapping by the females seems to be a "rejection dance" as in *L. arota*. Unreceptive females also raise their abdomens slightly so that males cannot join. Courtships were observed at 0916, 0930, 0931, 0938, 1113, 1122, 1155, 1332, 1444, 1502, 1540, 1610, and 1620. Copulating pairs were found at 0938 and 1122. Six of 26 dissected females had not mated, 18 had mated once, and two had mated twice. Most of these individuals were fresh, so that the number of matings might be expected to increase with age. The spermatophores

TABLE 1. Population parameter estimates of *L. xanthoides* at Berkeley study site.

	Day	Apha ¹	M ²	N ³ + 1.96 SE ⁴	Phi ⁵ + 1.96 SE	B ⁶ + 1.96 SE
Males	July 6	0.	0.	0. + 0.	.860 + .241	0. + 0.
	9	.7917	37.86	47.8 + 14.7	.933 + .548	-4.6 + 7.1
	11	1.0000	40.00	40.0 + 22.2	.912 + .787	2.6 + 4.5
	13	.9333	36.50	39.1 + 27.2	.327 + .294	-.5 + 1.8
	15	1.0000	12.25	12.2 + 7.8	0. + 0.	0. + 0.
	17	.8750	0.	0. + 0.	0. + 0.	0. + 0.
Females	July 6	0.	0.	0. + 0.	.721 + .215	0. + 0.
	9	.6316	31.00	49.1 + 18.5	.939 + .319	-.5 + 14.4
	11	.7826	35.69	45.6 + 15.6	.852 + .467	3.5 + 12.0
	13	.8182	34.67	42.4 + 23.8	.895 + .631	5.0 + 13.1
	15	.7647	32.83	42.9 + 25.9	0. + 0.	0. + 0.
	17	.7222	0.	0. + 0.	0. + 0.	0. + 0.
Both Sexes Combined	July 6	0.	0.	0. + 0.	.798 + .164	0. + 0.
	9	.7209	69.39	96.3 + 22.9	.907 + .275	-.3 + 16.0
	11	.8485	73.83	87.0 + 25.8	.951 + .456	2.0 + 13.7
	13	.8846	75.00	84.8 + 37.5	.564 + .324	5.0 + 9.5
	15	.8333	44.00	52.8 + 23.4	0. + 0.	0. + 0.
	17	.5556	0.	0. + 0.	0. + 0.	0. + 0.

¹ Proportion of marked animals.² Total marked population.³ Total population.⁴ Standard error.⁵ Probability of survival.⁶ Number of new animals joining the population.

of both *L. xanthoides* and *L. arota* disappear rapidly compared to those of other butterflies (Scott, 1973a), making counts more difficult.

Population parameters. In order to study movements and population parameters, a mark-release-recapture effort was carried out. Fifty-one males and 66 females were individually marked and released; of these, 32 males (63%) and 38 females (58%) were recaptured at least once. Because the study was done in a 30 × 40 m field, dispersal could not be followed. Within the study site, which was separated into six areas based on physical markers, many individuals changed position between recaptures, and of the individuals recaptured more than once, many crossed the area several times. Because the estimated lifespan of males was nine days and 14 days for females, it is assumed that very little emigration occurred. The surrounding area consisted of asphalt, lawns, and buildings, so that emigration would not have led to any favorable area nearby. The species may have colonized the lot by moving short distances along the creek which runs through the site. At the Point Richmond site adults were almost completely limited to flat areas at the base of a hill, although one male was found on a hilltop about 300 meters distant from the

nearest colony, and several others were found on other parts of the hill at least 100 meters distant from the closest larval host.

The number of males was about 40 at the beginning of the study, but declined at the end. The number of females remained at about 33 throughout the study. During the study period the number of new animals was very small for both sexes; adults probably began to emerge in late May or early June, and the mark-recapture effort was conducted near the end of the flight period. Population parameters for both sexes (Table 1) were estimated using the stochastic model of Jolly (1966).

The average survival rate and lifespan for males was .893 (8.9 days) using method 1, and .890 (8.6 days) using method 2. For females the rate was .932 (14.2 days) using method 1, and .933 (14.4 days) using method 2. For both sexes combined, the rate was .900 (9.5 days) using method 1, and .901 (9.6 days) using method 2. Five males and two females survived for at least the entire 11-day period. Many individuals went from fresh to battered wing-condition during the study period. The lifespan of *L. xanthoides* was much greater than the lifespan of *L. arota*; extensive predation and very hot weather at the *L. arota* study site may have reduced survival (Scott, 1973b).

Feeding. Both sexes visited flowers during warm sunny hours, especially early afternoon. Yellow flowers were visited most frequently because of their availability; elsewhere (Colorado) both sexes feed most often on blue-red *Asclepias* sp. (Asclepiadaceae). Plants whose flowers were visited at Berkeley were yellow *Grindelia* (Compositae), 130 visits; blue-white *Dipsacus* (Dipsacaceae), 15 visits; yellow *Brassica nigra* (Cruciferae), 1 visit; and yellow *Foeniculum vulgare* (Umbelliferae), 1 visit. At Point Richmond adults visited *Grindelia* and red-blue *Centranthus ruber* (Valerianaceae).

Oviposition. Oviposition was not observed. First instar larvae were found upon young leaves of *Rumex hymenosepalus* during February. Older larvae were found on the underside of slightly older leaves.

Thermoregulation. Both sexes bask by spreading their wings 20–60° from vertical, and facing away from the sun. Basking occurs at cool temperatures, primarily during morning and late afternoon.

SUMMARY

Males of *Lycaena xanthoides* perch on vegetation in open flat areas from approximately 0700 to 1600 and fly out at other insects in order to locate receptive females. Pre-mating behavior involves the male fluttering near the quiescent female. Unreceptive females flutter their wings until the male departs. The average lifespan is nine days for males and

14 days for females. Both sexes feed upon nectar from flowers of many colors.

ACKNOWLEDGMENT

We thank Jerry A. Powell for criticizing the preliminary manuscript.

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NOTES AND NEWS

THE LEPIDOPTERISTS' SOCIETY CONSTITUTION AND BY-LAWS
(AS AMENDED JANUARY 1974)

WHEREAS, The Lepidopterists' Society was formed on May 4, 1947, to promote the scientifically sound and progressive study of Lepidoptera by—

1. publishing a periodical on Lepidoptera.
2. facilitating the exchange of specimens and notes by both the professional worker and the amateur in the field,

AND WHEREAS, it is now proposed to organize said Society in a more formal manner, the following Constitution and By-Laws are hereby adopted by the duly appointed Organization Committee. [1 October 1950]

CONSTITUTION

ARTICLE I. NAME

Section 1. The organization shall be known as The Lepidopterists' Society.

ARTICLE II. OBJECT

Section 1. The Lepidopterists' Society is a non-profit educational and scientific organization. It shall be the purpose of the Society to promote internationally the science of lepidopterology in all its branches; to further the scientifically sound and progressive study of Lepidoptera; to publish periodicals and other publications on Lepidoptera; to facilitate the exchange of specimens and ideas by both the professional worker and the amateur in the field; and to secure cooperation in all measures tending to that end.

ARTICLE III. MEMBERSHIP

Section 1. All persons interested in lepidopterology shall be eligible for membership.

Section 2. All individual subscribers to the *Journal* and the *News of the Lepidopterists' Society*, who have paid their current dues, shall be deemed members of the Society.

Section 3. The membership of the Society shall consist of five classes—Active, Student, Sustaining, Life, and Honorary Life members. All persons who joined the Society before January 1, 1948, shall be designated Charter members.

Section 4. Application for Active, Student, Sustaining, and Life membership in the Society, received by the Secretary or Treasurer and accompanied by the appropriate dues for the current year, shall constitute formalization of membership, and no nomination or election to membership shall be necessary. The annual and life dues shall be fixed by the By-Laws.

Section 5. Any member may become a Life Member upon the payment, at one time, of such sum as shall be fixed by the By-Laws, and shall be exempt from further assessment. He shall receive during his life a subscription to the *Journal* and the *News of the Lepidopterists' Society*. Life Membership fees shall be placed in a permanent Publication Fund.

Section 6. Individuals who have made important contributions to the science of lepidopterology may be elected Honorary Life Members of the Society. There shall not be more than ten living Honorary Life Members.

Section 7. Members one year in arrears in the payment of dues shall be dropped from the rolls by the Secretary.

Section 8. The Executive Council may expel any member of the Society for such cause as it may deem sufficient for expulsion. This action may be taken only after unanimous approval by the members of the Council. Petition for expulsion shall be presented to the Secretary for presentation to the Council. On expulsion, the departing member shall be refunded all dues paid for the current year. An expelled member may be reinstated by unanimous affirmative vote of the Council.

ARTICLE IV. OFFICERS

Section 1. The officers of the Society shall consist of a President, President-elect, three Vice-Presidents (not more than one Vice-President shall reside in one country), a Secretary, a Treasurer, a Secretary-elect and/or a Treasurer-elect, in these two offices, in years when there are incumbents.

Section 2. The business and affairs of the Society, not otherwise provided for, shall be controlled by an Executive Council, consisting of the President, President-elect, the most recent available Past President, three Vice-Presidents, the Secretary, the Secretary-elect, the Treasurer, the Treasurer-elect, and nine other members of the Society. Action on all amendments to the By-Laws and all appointments and elections by the Executive Council shall be obtained by a canvass by the Secretary of all members of the Council.

Section 3. The Executive Council may appoint one or more Assistant Secretaries or Assistant Treasurers to serve during the pleasure of the Council. The offices of Assistant Secretary and Assistant Treasurer may be filled by the same person.

Section 4. The Executive Council shall have power to make and adopt By-Laws for the conduct of the business and affairs of the Society and for the regulations of its procedure not inconsistent with the terms and provisions of the Constitution.

ARTICLE V. ELECTIONS

Section 1. The President shall before the first of July appoint a Nominating Committee who shall nominate no more than two candidates for each elective office to be filled for the ensuing year. Additional candidates may be nominated by submission to the Secretary of written nominations signed by not less than ten members. Ballots containing all nominations shall be mailed in November of each year, setting forth the officers to be elected and the names of those nominated for any office, their names shall be arranged alphabetically on the ballot.

Section 2. Election of Officers. All officers shall be elected by ballot. The President and all Vice-Presidents shall be elected for the term of one year, and shall be eligible to succeed themselves once. The Secretary and Treasurer shall be elected for the term of three years and shall be eligible to succeed themselves twice. The nine other elective members of the Executive Council shall be elected for the term of three years; three of them shall be replaced each year; these members shall not be eligible to succeed themselves. The President, the Secretary and the Treasurer shall be elected a year prior to the time they take office. For each office, the nominee receiving the highest number of ballots shall be elected. The President, Vice-Presidents, and newly-elected Members-at-Large of the Executive Council shall take office at the Business Meeting of the Annual Meeting following their election; in the event that no Annual Meeting is held in a given year, these officers shall assume office on the anniversary of the last Annual Meeting. All other officers shall take office at the beginning of the calendar year for which they are elected.

Section 3. Election of Honorary Life Members. Honorary Life Members shall be nominated by the unanimous vote of the members of the Executive Council. The nominee shall be voted on by mail ballot distributed to all members of the Society and reported in one of the Society's periodicals, and must receive 80% of all ballots cast to be elected. Not more than five Honorary Life Members may be elected at the first Annual Meeting, and not more than two in any one calendar year.

ARTICLE VI. DUTIES OF OFFICERS

Section 1. The President shall preside at all meetings. He shall appoint all committees and be Chairman of the Executive Council and a member *ex officio* of all other committees, except the Editorial Board. He may appoint also delegates to other learned societies, congresses, and conventions.

Section 2. The First Vice-President shall assume the duties of the President in case of his death, resignation, absence, or disability.

Section 3. In case the President and all Vice-Presidents are absent at a meeting, a temporary Chairman may be chosen by a majority vote; he shall be member of the Executive Council unless none is present, in which event another member of the Society may be elected.

Section 4. The Secretary shall keep the minutes of the meetings of the Society and of the Executive Council; shall give notice of the meetings of the Society; shall attend to all general correspondence; shall keep all records and files of the Society; shall prepare and distribute ballots; and shall generally perform all services that may be delegated to him.

Section 5. The Assistant Secretary shall assume the duties of the Secretary in case of the death, resignation, absence, or disability of the Secretary, and shall assist the Secretary as need be.

Section 6. The Treasurer shall receive all monies for the Society and deposit them in the name of the Society in such banking institutions as the Executive Council shall direct. He shall pay therefrom by draft or check all bills and obligations of the Society; he shall keep an account of all monetary transactions and shall exhibit a statement of them when called for by the President or the Executive Council, and shall make a full report for the preceding calendar year at the annual meeting.

Section 7. The Assistant Treasurer shall assume the duties of the Treasurer in case of the death, resignation, absence, or disability of the Treasurer, and shall assist the Treasurer as need be.

Section 8. At the expiration of his term of office, each officer shall deliver to his successor all books, papers, funds, and vouchers belonging to the Society.

Section 9. The Society shall not and may not make any dividend, gift, division or bonus in money to any of its members.

ARTICLE VII. MEETINGS

Section 1. The annual meeting shall be held in affiliation with the International Congress of Entomology or the annual meeting of the American Association for the Advancement of Science, or at such other time and place as the Executive Council may determine. Notice of said meeting shall be given as provided in the By-Laws.

Section 2. Special meetings of the Society may be called by the Secretary upon the written request of the President or ten active members. Such request shall state the purpose for which the meeting is to be called and the time and place where it is to be held. No other business, except that specified in the call, shall be transacted, except by unanimous consent of the members present.

ARTICLE VIII. PUBLICATIONS

Section 1. The Society shall publish a periodical to be known as the "*Journal of the Lepidopterists' Society*," a continuation of *The Lepidopterist's News*. The *Journal* shall be devoted to original papers, literature abstracts, and other matter of permanent record. Each volume shall be issued for a calendar year, and shall be composed of four numbers. In it shall be published a summary of the proceedings of the annual meetings.

Section 2. The Society shall also issue a periodical to be known as "*News of the Lepidopterists' Society*," which shall be devoted primarily to notices by members,

lists of new members, announcements of nominations, committee appointments, forthcoming meetings, summaries of the recent field collecting season, and other matter of interest to members but not requiring permanent record. It shall appear at more frequent intervals than the *Journal*. A list of members of the Society shall be issued at least every second year.

Section 3. The Society may issue from time to time serial publications to be known as "*Memoirs of the Lepidopterists' Society*" to contain longer works than are normal for the *Journal* and the *News*. This shall be financed by a special fund, not by the annual dues, and shall be sold separately to members, at a lower price than to non-members.

ARTICLE IX. EDITORIAL BOARD

Section 1. The publications of the Society shall be under the charge of an Editorial Board, consisting of a Chairman and two other at-large members, the Editor of the *Journal*, the Editor of the *News*, the Editor of the *Memoirs*, and the two Associate Editors of the *Journal*. The Chairman may also be one of the above five editors. It shall determine broad publication policies of the Society not otherwise provided for in the Constitution or the By-Laws. It shall consider potential candidates for editorships and then make recommendations to the Executive Council for appointment of the three Editors.

Section 2. The Chairman of the Editorial Board shall be appointed by the Executive Council for the term of three years, and he may be reappointed. The Executive Council shall appoint, on recommendation of the Editorial Board, the three Editors, for terms of three years each; all three Editors may succeed themselves once.

The Associate Editors and other members of the editorial committee of the *Journal* shall be appointed by the *Journal* Editor; their terms shall terminate with his term, but his successor may reappoint any of them.

Editorial committees or staff members of the *News* and the *Memoirs* shall be appointed by the respective Editors, but their terms shall terminate with those of their Editors; they may be reappointed.

ARTICLE X. AUDITING COMMITTEE

Section 1. The President shall appoint an Auditing Committee consisting of three members who shall audit the accounts of the Treasurer and render their report to the Secretary before December 31st.

ARTICLE XI. LIBRARIAN

Section 1. The Librarian shall be appointed by the Executive Council. The Librarian shall serve for the term of three years, or until his successor shall have been appointed.

Section 2. The Librarian shall have charge of the library of the Society, and of all books, periodicals, reprints, and historical material received by the Society. He may make all necessary rules and regulations for the use of the library, not otherwise provided for in the Constitution or the By-Laws.

ARTICLE XII. AMENDMENTS

Section 1. The Constitution may be altered, amended, or repealed by a two-thirds vote of the members voting by mail ballot. Each proposal for amendment must be signed by not less than five members of the Society and submitted to the Secretary who will promptly transmit it to the Editors of the *Journal* and *News*. Each proposed amendment shall be published in one of the Society's periodicals at least three months before the annual ballot is mailed in November.

Section 2. The By-Laws may be altered, amended, or repealed, by a majority vote of the members voting, at any meeting of the Executive Council or in a mail-canvass of the Council by the Secretary. All changes so validated shall be published in one of the Society's periodicals.

ARTICLE XIII. DISSOLUTION

Section 1. Upon final dissolution or liquidation of the Society, all of its properties and assets remaining after payment of all outstanding liabilities shall be transferred, assigned and paid over as follows: The American Museum of Natural History, Central Park West at 79th Street, New York, New York 10024, and the California Academy of Sciences, Golden Gate Park, San Francisco, California 94118.

If any of the named organizations no longer qualify for exemptions under Section 501 (c) (3) of the Internal Revenue Code, or are not in existence, or unable or unwilling to accept such assets, such properties and assets shall be distributed to such organization or organizations organized and operated exclusively for charitable or educational purposes as shall at the time qualify as an organization or organizations exempt under Section 501 (c) (3) of the Internal Revenue Code of 1954 (or corresponding provision of any future United States Internal Revenue Laws), as the Executive Council shall determine.

ARTICLE XIV. GENERAL PROHIBITIONS

Section 1. Notwithstanding any provision of the Constitution or By-Laws which might be susceptible to a contrary construction:

- (a) the Society shall be organized exclusively for scientific and educational purposes;
- (b) the Society shall be operated exclusively for scientific and educational purposes;
- (c) no part of the net earnings of the Society shall or may under any circumstances inure to the benefit of any private individual;
- (d) no substantial part of the activities of the Society shall consist of carrying on propaganda, or otherwise attempting to influence legislation;
- (e) the Society shall not participate in, or intervene in (including the publishing or distributing of statements), any political campaign on behalf of any candidate for public office;
- (f) the Society shall not be organized or operated for profit;
- (g) the Society shall not:
 - (1) lend any part of its income or corpus, without receipt of adequate security and reasonable rate of interest, to;
 - (2) pay any compensation, in excess of a reasonable allowance for salaries or other compensation for personal services actually rendered, to;
 - (3) make any part of its services available on a preferential basis to;
 - (4) make any purchase of securities or any other property, for more than adequate consideration in money or money's worth, from;
 - (5) sell any securities or other property for less than adequate consideration in money or money's worth to; or
 - (6) engage in any other transactions which result in substantial diversions of its income or corpus to; any officer, member of the Governing Board, or substantial contributor to the Society.

The prohibitions contained in this subsection (g) do not mean to imply that the Society may make such loans, payments, sales or purchases to anyone else, unless such authority be given or implied by other provisions of the Constitution or By-Laws.

BY-LAWS

ARTICLE I. DUES

Section 1. All dues shall be payable by January 1 of each year, and shall be deemed in arrears on February 15 of that year.

Section 2. Publications of the Society shall not be mailed to any member whose dues are in arrears.

Section 3. The annual dues shall be waived for the Secretary, the Treasurer, and the Editors of the *Journal* and *News*, while they are in office; they shall continue to receive all publications of the Society.

Section 4. Honorary Life Members shall pay no annual dues, but shall receive a subscription to all publications of the Society.

Section 5. Beginning with 1971, the annual dues for Active Members shall be Ten Dollars, U.S.A. (\$10.00). Active membership shall include a subscription to the *Journal of the Lepidopterists' Society*, including *Supplements*, and the *News of the Lepidopterists' Society*.

Section 6. Beginning with 1973, the annual dues for Student Members shall be Seven Dollars and Fifty Cents, U.S.A. (\$7.50). Student membership shall include a subscription to the *Journal of the Lepidopterists' Society*, including *Supplements*, and the *News of the Lepidopterists' Society*.

Section 7. Beginning with 1971, the annual dues for Sustaining Members shall be Twenty Dollars, U.S.A. (\$20.00). Sustaining membership shall include a subscription to the *Journal of the Lepidopterists' Society*, including *Supplements*, and the *News of the Lepidopterists' Society*.

Section 8. Beginning with 1971, Life Members shall pay the sum of One Hundred Fifty Dollars, U.S.A. (\$150.00). Each Life Member shall receive a subscription to the regular Society publications during his life.

Section 9. Beginning with 1971, institutional subscription fees shall be Fifteen Dollars, U.S.A. (\$15.00). This will include the *Journal of the Lepidopterists' Society*, including *Supplements*, and the *News of the Lepidopterists' Society*.

ARTICLE II. GIFTS

Section 1. The Society shall not make gift memberships to individuals or subscriptions to institutions. Society members are encouraged to sponsor gift memberships to deserving lepidopterists in foreign countries whose monetary policy prohibits sending currency out of their country.

Section 2. The Society may exchange issues of the *Journal* for other desirable lepidopterological periodicals upon the approval and recommendation of the Society Librarian. Such acquisitions shall remain in the Society Library, but may be loaned to its members in good standing.

ARTICLE III. REPRINTS

Section 1. Beginning with 1971, gratis separates (tear sheets) to *Journal* authors will be discontinued.

ARTICLE IV. MEETINGS

Section 1. Notice of all meetings of the Society shall be printed in the *News of the Lepidopterists' Society* at least two months in advance thereof.

Section 2. A majority of members present at an annual meeting, or represented by proxy, shall constitute a quorum for the transaction of business, not otherwise provided for.

BOOK REVIEWS

EMPEROR MOTHS OF SOUTH AND CENTRAL AFRICA, by Eliot Pinhey. 1972. C. Struik, Cape Town. xi + 150 p., illus. + 43 plates (15 in color). Price \$12.95 (U.S.).

Emperor moths, Saturniidae, are well-represented in Africa south of the Sahara, and almost everywhere a rich variety of species can be expected. This book is essentially a guide to the identification of species found in southern Africa, north as far as Zambia, Malawi and Mozambique. Emperors are large and conspicuous and thus attract the attention of collectors. As a result the life histories of many species are well-known, which is certainly not true for the bulk of African moths. The caterpillars and their foodplants are described and documented, and there are introductory sections on structure and classification. The caterpillars of a quite remarkably large number of species appear to have become adapted to introduced plants. A few are pests, and some are utilized as human food.

The book is intended primarily for the collector. There is little emphasis on ecology, behavior and conservation. The text is rather long-winded and anecdotal, but includes an amusing list of derivations of scientific names. The plates, together with numerous drawings of male genitalia, should facilitate the identification of species in southern Africa, and will certainly help in placing specimens from the more tropical parts of the continent.

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WATCHING WASHINGTON BUTTERFLIES, by Robert Michael Pyle. 1974. Seattle Audubon Society, Joshua Green Bldg., Seattle, Washington 98101. 109 p., 64 color and 2 black-and-white photographs, 1 line drawing, 1 map; foreword by Roger Tory Peterson. Price: \$3.95 (U.S.) plus \$.30 shipping charge for first copy, \$.20 for each additional copy.

This charming book, put out as a companion to *Washington Wildflowers* in the same series, represents the first full-scale treatment of the butterfly fauna of any northwest state, and is the author's thesis for his Master of Science degree in Nature Interpretation. In obtaining accurate data he has enlisted the help of a goodly number of prominent lepidopterists both in and out of the State of Washington. The book is unusual in that it places the emphasis on watching rather than collecting butterflies, and the color photographs taken by the author of the living insects reflect this attitude. It is aimed primarily at the amateur nature walker, but the serious student will find in the detailed descriptions very professional information on field identification, habitat, egg, larval and pupal characters; and the habits and natural history of each species. It is one of the few books I know which combines the simplicity attractive to the novice, with scientific documentation making it a necessary addition to the professional's library. Descriptive information on the life histories is relatively complete and includes all appropriate botanical and clinal references. Sections are included on perceiving butterflies, photography, breeding, creating butterfly gardens, a list of helpful books and collections, and a check list. A detailed chapter on the butterfly ecology of the State of Washington includes divisions on zoogeography, physiogeography, and the life zones and vegetational units of the state, with a map of the geographic provinces described. In the latter section the author takes the reader on a vicarious tour of the State of Washington, through each of these major areas, in a most delightful manner with many suggestions

as to the best way of reaching the areas described. In the course of the tour, clear reasoning shows why certain butterflies are to be found or not to be found in the area described. Notable is the fact that the writing is extremely literate and reveals the author's sensitivity to nature. The book is charming and delightful to read, and will be found equally useful in the adjacent states and British Columbia. In its broader aspects, the perception of butterflies, the creation of butterfly gardens, photography, and the clinal aspects of distribution, this book will be of value to collectors and butterfly watchers in all parts of the country.

Details of taxonomy are deliberately excluded since the emphasis is on field identification; and the author does not go into the subspecies problem. He does, however, mention the lower taxon on occasions where he feels it necessary in order to avoid confusion. In this reviewer's opinion his handling of the subspecific problem is done well and is an added asset. A further comment is that he fails to mark parentheses around the author of such species as have had their specific names changed from their original genera. This, however, is a small point which will affect only those who plan to use the book as a taxonomic treatise, which is not its intention. Adequate references are given in the section on books and collections.

The author is currently undertaking doctoral studies at Yale University's School of Environmental Studies, and is the founder and director of the Xerces Society, the first international organization for the conservation of butterflies.

Without reservation I recommend this as an excellent and thoroughly readable book, packed with carefully researched information on every species of butterfly presently known in the State of Washington.

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This is an aggravating little book. Because it embodies an outstanding idea—promoting butterfly-watching (alongside collecting) as a pleasurable and conservation-minded outdoor activity—one wants to praise it. Unfortunately, *Watching Washington Butterflies* is also the first faunistic book for the Pacific Northwest. As such it will probably remain the standard reference for some time—and in that role it leaves much to be desired.

First, the good points. *Watching Washington Butterflies* has unusually complete descriptive material on ecological regions and butterfly habitats, and attempts to put butterflies in a broader ecological perspective than any butterfly book since Klots. Pyle is the founder of the Xerces Society and is the most articulate and dedicated exponent of butterfly conservation in America, and this theme runs all through the book; there is more information about gardening to attract butterflies than about collecting, mounting, etc.! The field marks, based on the Peterson system, are simply presented and easy to grasp. And the photographs are all in color, beautifully reproduced, and all from life. This is the first American butterfly book since Aretas Saunders' *Butterflies of the Allegany State Park* (1932) illustrated exclusively with photographs of living specimens in the wild. It's about time!

Now the bad points: first, and most annoyingly, six of the 64 color figures are incorrectly identified. Specifically, fig. 7, supposedly *Pieris sisymbrii*, is *Euchloe hyantis*; figs. 30–31, labeled *Everes comyntas*, are *E. amyntula* (*E. comyntas*, as far as I know, has never been found in Washington at all); figs. 40–41 are *Polygonia faunus*, not *P. zephyrus*; and fig. 64 is certainly not *Erynnis icelus*—it might be *persius*, but is most likely *propertius*.

Second, and almost as annoyingly, the larval host plants are given for many species but there is no indication in most instances where the records come from. Are they actual field data from Washington, or the usual extracts from the literature (where things are "validated" by repetition)? For example, *Lycæna helloides* is listed as feeding on "*Polygonum*, cinquefoil, dock." Since one cinquefoil-feeding

population is known (in a salt-marsh environment) in California, and the *dorcas*-type populations of the far north also feed on these plants, one wants to know—do Washington *helooides* feed on *Potentilla* or not? The host of *Colias occidentalis* is listed as “Legumes.” Anyone who has tried to rear this beast knows how fussy it is. What Legumes? Almost every host-association ambiguity which plagues California Lepidopterists reappears here, suggesting that not much has happened on the Pacific coast since Comstock’s 1927 *magnum opus*.

Third, misspellings appear everywhere. “*Crysalis*” rears its head at least ten times. Botanical names suffer the most. *Ceanothus* is always given as *Ceonothus*. Less consistently we are treated to *Purschia*, *Gnophalium*, *Arceuthabium*, *Quercas*, *Orthocarpos*, *ad infinitum*, *ad nauseam*.

Fourth and fifth, there is virtually no discussion of variation, be it seasonal or geographic, and all matters taxonomical are given very short shrift. The latter is desirable in a popular natural-history guide, which is what this book is supposed to be, but not in a “standard” faunistic reference, which it is going to be whether or not that was the author’s intent.

A few minor changes would make the book easier to use. The figures are numbered independently of the species, and cross-referencing is difficult, especially if one is in a hurry (as one usually is afield). Giving the figures the numbers of the species they portray would speed things up. The system for giving flight seasons is a convenient shorthand, perhaps, but takes some getting used to. A book which has space for Buddhist scripture has space to use words like “early” and “late.”

Finally there are questions of “style,” and here individual tastes are bound to vary. Popular field guides should be light and fun to read, but Pyle perhaps tries too hard. I find his prose unpleasant reading, often gushy, turgid or cloying. The name he coins for *Philotes battoides*, the “Bat Blue,” ranks with Austin Clark’s *Cercyonis* folly—“Goggle Eye”—in the competition for the worst vernacular name ever.

One aspect of the book which may be unjustly faulted in some quarters, is its emphasis on non-consumptive “uses” of Nature. Pyle’s view of lepidopteran population dynamics and of the impact of collecting is a sensible and balanced one. Butterfly watching is arresting because of its novelty after generations of collecting emphasis; it is an alternative to—not a replacement for—collecting, and each activity has its proper place.

There are lots of distributional “goodies” in this book, which is only to be expected since so little on Washington butterflies has appeared before, but specialists will find themselves constantly frustrated by the absence of any information about phenotypes, subspecies, and the like. Lycaenid enthusiasts will be intrigued by the range extensions for *Lycaena cupreus* and *editha* (to name two), the absence of *L. nivalis* from the western Cascades (when it occurs on the west slope of the Olympic Mountains), etc. Since the basic premise of *Watching Washington Butterflies* is so good, one can only hope its first edition sells out rapidly so a new one—with the kinks taken out—can be ready soon.

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GENERAL NOTES

OCCURRENCE OF *SPEYERIA IDALIA* (NYMPHALIDAE) ON
REMNANT PRAIRIE IN NORTHWEST WISCONSIN

Although intensely local and restricted to areas of virgin prairie, *Speyeria idalia* (Drury) is widely distributed over the north central United States. Surprisingly, there have been no records for northwest Wisconsin (Ebner 1970, Milwaukee Public Mus. Popular Sci. Hbk. 12; Masters 1973, J. Res. Lep. 11: 175-182) although the original vegetation of Wisconsin included prairie areas extending as far northwest as St. Croix, Polk and southern Burnett counties. During the summer of 1972, I located small remnant stands of virgin prairie in St. Croix, Polk, Eau Claire, Chippewa and Dunn counties and discovered that small populations of *S. idalia* occurred on many of them. Prairie areas were located by carefully searching railway right of ways (many railways were built in this area before it was heavily settled), cemeteries, and in areas of shallow, rocky soil where agriculture has never been attempted. The localities surveyed are:

POLK COUNTY. Very nice stands of dry (xeric) prairie are found on exposed hilltops in the Interstate State Park. These prairie areas are relatively inaccessible and are virtually undisturbed. They are excellent areas to study xeric prairie flowers. Although I spent quite a bit of time here, *S. idalia* was not observed. It is quite possible that the area is too dry and it never occurred here. I was unable to locate any additional prairie stands in Polk County through searching railway right of ways and cemeteries.

ST. CROIX COUNTY. Several small stands of virgin prairie were located along railway right of ways in St. Croix County. Although they were all of small size and somewhat disturbed, a small population of *S. idalia*, often just one example, was found on each of them. Specific localities as follows:

Hudson Twp. (T 29 N—R 19 W): SESE sec. 17, a very small population on about ¼ acre of prairie along railway right of way; SESE sec. 13, one specimen taken along traces of remnant prairie along railway. Warren Twp. (T 29 N—R 18 W): SENW sec. 19, a small population of 15 acres of land belonging to the C. St. P. M. & O. Railroad. Richmond Twp. (T 30 N—R 18 W): NWNE sec. 10, one specimen taken on prairie bordering railway; NESW sec. 16, a sight record along railway.

Remnant Oak Openings, which are closely related to prairies with many flowers in common, were found in the Willow River State Park, however, *S. idalia* was not observed here.

DUNN COUNTY. The tracks of the C. & N. W. Railroad run parallel to highway 12 across Dunn County. I carefully traced this entire route and, although I did find a few very small patches of prairie, I did not observe *Speyeria idalia*.

EAU CLAIRE COUNTY. Quite a bit of collecting was done in Pine Barren areas of Seymour Twp. (T 27 N—R 8 W). The Pine Barrens have many plant species in common with the prairies and there is even some degree of intergradation between Pine Barren and Xeric Prairie. In fact, this is the only location in Wisconsin where I have actually found the assumed foodplant for *S. idalia*, the Birdfoot Violet (*Viola pedata*). I did not take or observe *S. idalia* in Eau Claire County, however Fay Karpuleon of Eau Claire, reports having taken one specimen in the Pine Barrens on 15 July 1972.

CHIPPEWA COUNTY. There are small patches of virgin prairie in fairly good condition all along the C. & N. W. Railroad tracks between Eau Claire and Chippewa

Falls. I collected one male of *S. idalia* on a 10 acre patch in Hallie Twp. (T 28 N—R 9 W): SWSE sec. 13. No further attempts were made to locate the species in Chippewa County.

CONCLUSIONS

Speyeria idalia is established and apparently able to maintain itself in very small populations on small (in some cases as little as $\frac{1}{2}$ acre) remnant prairie in northwest Wisconsin. All of the ascertained localities were along railroad right of ways, which casts some doubt upon their future. In recent years the railroads have shown an increasing tendency to sell off excess land and to use herbicides for weed control along right of ways instead of burning as they have done in the past. These practices may very well result in the final demise of this type of remnant prairie.

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THE "GREASY" WING GENE OF *UTETHEISA ORNATRIX* (ARCTIIDAE)

The genus *Utetheisa* Hübner is represented by *Utetheisa bella* Linnè and *Utetheisa ornatrix* Linnè which are normally allopatric in the New World. *U. bella* is common in the southern U.S.A., migrating northward each season to feed on *Crotalaria*. Isolated seasonal populations in the north can produce huge multi-brooded local populations, demonstrating the genetic diversity of the genome of the original migrants. Remington (1956, Proc. 10th Internat. Cong. Ent. 2: 797–803) and Pease (1968, Evolution 22: 719–736) determined the genetic background of the principal morphological characters of the genus, noting the character differences and their frequencies within the five subspecies of the *Utetheisa ornatrix* group.

The author's collection contains 837 specimens of *U. bella* taken at an isolated locality five miles north of Liverpool, Pennsylvania, over a period of five weeks in 1969. This sample contains all of the subspecies phenotypes described by Pease. A similar sample of 60 specimens was taken at the same location during a three-week period in 1973 with the same phenotypic frequencies observed in 1969. These samples show no character that would indicate the intrusion of *U. ornatrix* genome in these migrants. The white ground color of the forewing for example, is uniform throughout.

U. ornatrix is rare in the United States but is common throughout Mexico and Central America wherever its food plant, *Crotalaria*, is growing. Unlike *U. bella*, which is highly variable, *U. ornatrix* is constant in its pattern. The forewings are white, except for a red costal line broken by black dots; three marginal rows of black-red-black dots extend from the costal markings in varying degrees of intensity. The hindwings are white with wide black margins. Thus mass samples appear to be quite uniform, except for an occasional red blotching or streaking on the forewing.

Areas of sympatry of *U. bella* and *U. ornatrix* provide an interesting array of patterns on the interspecific hybrids. Such a hybrid population exists in southern Florida.

The analysis of a large sample composed of 81 males and 31 females of *U. ornatrix* taken 10 August 1972 at Oxchuc, Chiapas, Mexico revealed the presence of a new character designated as "greasy" which gives the usually immaculate white forewing so common in this species a dull vitreous grey color. Other characters were those usually associated with *U. ornatrix*; all had white hindwings, all had pale forewing dorsal discs (two males with red blotching), and all but one male and one female had unspotted forewing dorsal discs. In addition, all had wide hindwing black margins.

TABLE 1. Presence of "greasy" wing gene of *Utetheisa ornatrix* Linnè.

	Normal Wing Gene		"Greasy" Wing Gene	
	♂♂	♀♀	♂♂	♀♀
Ajijic, Jalisco, Mexico	21	10	0	8
Oxchuc, Chiapas, Mexico (Author's Sample)	80	16	0	16
Jãã Pessoa, Paraiba, Brazil	21	11	0	8

The author discussed with Dr. Charles L. Remington, Yale University, the presence of this new gene, which provides a greasy appearance for those specimens possessing it. A survey of mass samples in the Peabody Museum Collection, Yale University revealed the presence of the gene in other Central and South American populations (Table 1).

From these data one can infer that the presence of this gene is wide spread geographically. Its presence will no doubt be evident in many Central and South American populations of *U. ornatrix*.

The author's, Oxchuc sample and those at Yale, appear to be an "all or none character" which is sex influenced since it appears only in the females in a 1:1 ratio. The gene appears to be exclusive to *U. ornatrix* since it has not been observed in the mass samples of *U. bella*. The limited number of interspecific hybrids taken in southern Florida do not reveal the "greasy" condition either.

Collectors in Central and South America should mass sample *Utetheisa* when the species is abundant in hopes of providing evidence of the "greasy" wing gene in populations between southern Mexico and central Brazil. Also, an analysis of collected mass samples elucidating the presence of this character would provide additional evidence of its distribution and its true genetic nature.

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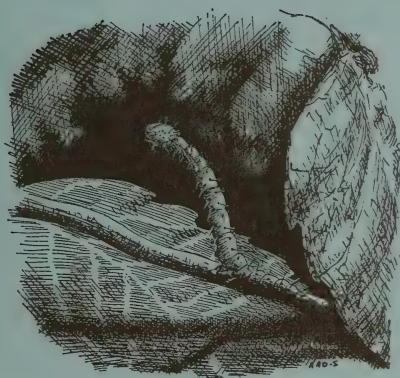
LEPIDOPTERISTS' SOCIETY

Published quarterly by THE LEPIDOPTERISTS' SOCIETY

Publié par LA SOCIÉTÉ DES LÉPIDOPTÉRISTES

Herausgegeben von DER GESELLSCHAFT DER LEPIDOPTEROLOGEN

Publicado por LA SOCIEDAD DE LOS LEPIDOPTERISTAS



10 June 1975

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JOURNAL OF THE LEPIDOPTERISTS' SOCIETY

Volume 29

1975

Number 2

PAPILIO "GOTHICA" AND THE PHENOTYPIC PLASTICITY OF *P. ZELICAON* (PAPILIONIDAE)

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Since the description of *Papilio gothica* Remington (Remington, 1968), its taxonomic status and the nature of its relationship with *P. zelicaon* Lucas have remained unclear (Clarke & Sheppard, 1970). *Papilio gothica* (type locality Gothic, Gunnison Co., Colorado) was proposed to apply to univoltine, montane populations from the Rocky Mountains and adjacent areas, showing an alleged host preference for (or restriction to) *Pseudocymopterus montanus* (Gray) Coulter & Rose (Umbelliferae), and differentiable from lowland California *P. zelicaon* in the phenotypes of their F₁ hybrids with *P. polyxenes* Fabricius and *P. bairdii* Edwards. Actual or potential reproductive isolation from *P. zelicaon* was not demonstrated. Remington was unable to find any "all or none characters . . . by which every dead specimen would be infallibly recognized," but he did provide a list of 11 characters whereby "most *gothica* differ from most *zelicaon*. . . ." He cited four of these as "the most reliable for distinguishing adults of montane Colorado *gothica* from lowland coastal Californian *zelicaon*." In his discussion of the geographical distributions of *zelicaon* and *gothica* he tentatively assigns genetically unknown populations to one or the other name, based on these pattern characters.

In many species of butterflies lowland, multivoltine populations produce vernal (or vernal/autumnal) phenotypes which are very similar to—if not indistinguishable from—those emerging in the single annual brood at high elevations or latitudes. Klots (1951) refers to this situation in *Papilio glaucus* L. ("canadensis" phenotype) and *Lycaenopsis pseudargiolus* Bdv. and LeC. ("lucia"). In California, it occurs in *Polites sabuleti* Bdv. ("tecumseh" phenotype) and *Pieris occidentalis* Reak. ("calyce"), to name two species under study in my laboratory. *Papilio*

zelicaon is continuously brooded in the Sacramento Valley of California, flying from March–October or November, with four to five broods. Since virtually every multivoltine butterfly studied (even the dull, dark species of *Erynnis*; Burns, 1964) shows seasonal phenotypic changes, it is scarcely surprising that *P. zelicaon* does so. The *gestalt* of the spring phenotype is immediately recognizable, but it has never been described in detail, or quantified as frequencies and correlations of individual character states. I propose that the seasonal phenotypic variability of *P. zelicaon* has a bearing on the validity of Remington's characterization of *P. gothica*.

When Remington's set of 11 *gothica* characters is examined in large samples of lowland California *zelicaon*, it becomes evident that spring *zelicaon* differ from their summer counterparts in precisely the same ways that *gothica* is alleged to differ from *zelicaon*. I have examined 320 *zelicaon* collected below 500' in six central California counties in 1972, 1973, and 1974, mostly as singletons or in series of ten or fewer. There are, however, two large series collected at single localities on single days: 12♂, 16♀ from Suisun City, Solano Co., 20 March 1974, and 35♂, 4♀ from the American River Parkway, Sacramento Co., 2 June 1973. These represent the first and second generations in their respective localities and years. Suisun City (elevation ca. 10') and the American River (ca. 15') are approximately 50 air miles apart, and potentially isolated from each other by the Inner Coast Ranges, which rise from a low pass at Vacaville, eight miles east of Suisun, to a crest of 2800' a few miles to the north. However, hilltopping *P. zelicaon* have been taken along the crest, and breeding populations exist in and on both sides of the pass, along Interstate Highway 80. Suisun City has a distinctly more maritime climate than the American River; it is exposed to afternoon sea breezes and occasional summer fog entering through the Carquinez straits. Both populations feed on the introduced umbelliferous weed, *Foeniculum vulgare* Mill., to the apparent exclusion of all other (native and introduced) umbellifers.

The four "most reliable" *gothica* characters (Remington's characters 2–5) are:

(2) Forewing below, in postmedian broad yellow band, with the anterior spot having an outer edge strongly offset from a line drawn through the outer edges of spots 2–9.

(3) Forewing below with postmedian spot 2 tending to have its outer edge forming an angle with its caudal edge only slightly greater than 90°. (In *zelicaon* this is described as "much greater than 90°.")

(4) Forewing above, near coastal edge, usually with 2 fine yellow lines opposite end of cell, one anterad and one posterad of the closely parallel veins Sc and R₁.

(5) Hindwing above has cell Cu₂, near the anal margin, with basal dark

TABLE 1. Distribution of character states in two samples of lowland California *Papilio zelicaon*. The characters are described in the text (G = *gothica* state; Z = *zelicaon* state).

Remington's numbered characters		2	3	4	5
Suisun City, 20 March 74 (1st generation)	12 ♂ ♂	8G: 4Z	4G: 8Z	6G: 6Z	7G: 5Z
	16 ♀ ♀	10G: 6Z	11G: 5Z	13G: 3Z	8G: 8Z
	28	18G:10Z	15G:13Z	19G: 9Z	15G:13Z
American River, 2 June 73 (2nd generation)	35 ♂ ♂	6G:29Z	6G:29Z	4G:31Z	7G:28Z
	4 ♀ ♀	2G: 2Z	1G: 3Z	0G: 4Z	3G: 1Z
	39	8G:31Z	7G:32Z	4G:35Z	10G:29Z
χ^2 within characters	χ^2	12.65	9.9	21.93	6.6
	p:	<< .005	< .005	<< .005	~ .010

color usually extending far distad of origin of vein Cu₂ from cell. (Described as greatly reduced in *zelicaon* males.)

For each specimen in the two long one-day series, each of these characters was scored as being in the *gothica* (G) or *zelicaon* (Z) state. The results are summarized in Table 1, along with the chi-square test for homogeneity of the two samples in each character; for all four characters the distributions of states in the two samples differ at a high level of significance. As may be seen from Table 2, the frequency of *gothica* character states deviates significantly from a random (Poisson) pattern in the spring, but not the summer sample. Point correlation coefficients (Poole, 1974) were calculated within each sample between all possible pairs of characters to test for association among character states (Table 3). Characters 3 and 4 have the strongest association in both samples, while 3 and 5 are essentially independent of each other. It is clear that the spring phenotype is not produced *in toto*, by the action of a major "switch-gene."

Remington suggests that *gothica-zelicaon* sympatry should be sought "at mountain-lowland contacts in central and eastern California." Can the distribution of *gothica* characters in these samples be explained in terms of introgressive hybridization? The American River Parkway sits at the base of one of the major canyons of the west slope of the Sierra Nevada, precisely where Remington predicts contact between *zelicaon* and *gothica*, but the June sample from there shows essentially no *gothica* tendencies. Suisun City is very nearly on the coast and is within easy flying range of the large vacant-lot populations in Oakland and Richmond. The March sample from Suisun City is phenotypically strongly reminiscent of the picture Remington portrays of *gothica*. These ob-

TABLE 2. Distribution of *gothica* (G) and *zelicaon* (Z) character states among numbers of characters, and their fit to a Poisson distribution (assumed independence among the characters).

Number of characters in G state	Number of Individuals Observed (O)	Number Expected from Poisson (E)	$\frac{(O - E)^2}{E}$
Suisun City, 20 March 74			
0	0	7.84	7.84
1	4	9.80	3.43
2	11	6.44	3.23
3	11	4.08	2.77
4	2	0.84	1.60
			$\chi^2 = 18.87,$
			$p < .005$
American River, 2 June 73			
0	19	11.65	4.64
1	12	14.04	0.29
2	6	9.36	1.21
3	2	1.56	0.12
4	0	0.39	0.39
			$\chi^2 = 6.65$
			$.10 > p > .05$

servations make no sense biogeographically, but they do seasonally. I have 45 summer *zelicaon* (collected on 16 different days) from Suisun and 20 spring *zelicaon* (6 days) from the American River, and their phenotypes confirm the seasonal pattern. (For example, of six taken on 19 March 1974 at the American River, one has 1, four have 2, and one has all 4 of its characters in the *gothica* state.) The only alternative hypothesis, that *gothica* and *zelicaon* are sympatric in lowland California with the former being spring-univoltine and the latter summer-multi-voltine, is not only not parsimonious; it is demonstrably incorrect from my breeding experiments at Davis.

The tendency for spring *zelicaon* to resemble *gothica* is not restricted to the four "most reliable" characters. In the Suisun and American River samples, nine of the eleven characters are significantly more like *gothica* in spring. The tenth, ground color of females, could not be evaluated because so few American River females were on hand. The eleventh, absence of yellow striping in the ventral forewing discal cell, was proposed as a trait distinguishing *zelicaon* and *gothica* from *P. brucei* Edwards.

TABLE 3. Point correlation coefficients (V) between all possible pairs of characters 2, 3, 4 and 5. The variances have been omitted.

Remington's numbered characters		3	4	5
Suisun City, 20 March 74	2	-.096	-.024	-.344
	3		+.126	0
	4			-.192
		3	4	5
American River, 2 June 73	2	+.258	+.247	+.105
	3		+.282	+.004
	4			-.212

None of this proves anything about the specific distinctness of *gothica*. If speciation is to be defined biologically, it can be "proven" only by the demonstration of reproductive isolation, a demonstration Remington has not made (Clarke & Sheppard, 1970). Decisions on species distinctness based entirely on statistical analysis of dead specimens, in the absence of biological data, can readily lead to absurd conclusions, e.g., the revision of *Pieris*, by Abbott et al. (1960) in which four very distinct (and widely sympatric) species group "*protodice*" species are synonymized. On the other hand, there is no doubt that sibling species exist which are indistinguishable to the museum taxonomist but meet all the biological criteria of speciation. Ayala (1973) described two partially isolated subspecies of the *Drosophila willistoni* group which are "nameable" only statistically, by the frequency pattern of isozymes when they are subjected to starch gel electrophoresis! If *Papilio gothica* proves to be a valid species, it will be "nameable" only by the locality label. Remington's characters are clearly useless for discriminating individual *gothica* from individual spring specimens of multivoltine *zelicaon*. (Since he did not quantify his diagnosis, we do not even know whether series of Colorado *gothica* and spring California *zelicaon* are statistically separable.) The only readily recognizable entity is summer, lowland *zelicaon*. The adaptive significance of these characters is unknown (the blackening in cell Cu₂ is likely to function in thermoregulation), but since they seem to be associated with diapause in both uni- and multivoltine populations, there is no reason to predict any correlation with the *gothica* × *polyxenes* (or *bairdii*) hybrid phenotype—on which the name *gothica* now wholly depends.

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CORRECTIONS TO TWO ARTICLES ON ABERRANT *CYNTHIA* (NYMPHALIDAE)

Two recent articles on aberrant *Cynthia* have contained errors of identification which should be corrected to prevent perpetuation of inaccurate records. Phillips (1971, Great Basin Natural. 31: 256-260) reported the capture of *Cynthia cardui* ab. *elymi* Rambur from Salt Lake City, Utah. This aberration, illustrated in color, is clearly *C. annabella* ab. *letcheri* Grinnell, which is easily distinguished from *C. cardui* ab. *elymi* by the forewing discal cell marking which completely crosses the cell in *C. annabella* but remains a spot against the anterior cell margin in *C. cardui*, and by the forewing apex which is pointed at M_1 in *C. annabella* and more rounded in *C. cardui*. *C. cardui* ab. *elymi*, then, remains unrecorded for Utah.

Shapiro (1973, Pan-Pac. Entomol. 49: 289-293) described and illustrated aberrations of *C. annabella*. His Figs. 1 and 2 are indeed *C. annabella*, but Fig. 3 is *C. cardui* showing tendencies toward ab. *elymi*. The same characteristics used to separate *C. annabella* ab. *letcheri* and *C. cardui* ab. *elymi* in the previous article can be used to correctly determine this specimen.

When used with care the excellent color illustrations of aberrant *Cynthia* (= *Vanessa*) in Comstock's *Butterflies of California* (1927) should leave no doubt as to the correct species identifications of some aberrations. However, the above mistaken identifications show the difficulty of applying names to aberrations, which by their very nature can be quite variable.

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NOTES ON THE BIOLOGY OF
ORNITHOPTERA GOLIATH AND
O. CHIMAERA (PAPILIONIDAE)

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Ornithoptera goliath Oberthur and *O. chimaera* Rothschild are included in the subgenus *Schoenbergia*, for which information on the early stages is scanty. Jordan (1908) mentions of *O. goliath*: "it has been bred several times but nothing appears to have been published."

Ornithoptera goliath titan Grose-Smith

O. goliath (Fig. 9) is one of the rarest *Ornithoptera* species. It is widely distributed, from the island of Ceram (East Indonesia), Waigeu, the whole mainland of New Guinea to Goodenough Island. However, it is always rare and very local. Its rarity may be due to the scarcity of its *Aristolochia* hostplant and the peculiar way mature larvae almost totally destroy their host before pupation.

Early Stages

Egg (Fig. 1). Very large, diameter 4.6–4.7 mm. Yellowish, pearly white, slightly flattened at the base. Generally deposited on mature leaves of the hostplant. Incubation period varied from 14 days (Sogeri, altitude 500 m.) to 19 days (Wau, altitude 1300 m.) depending on local average temperatures.

First instar larva (Figs. 2–3). Groundcolour of head, prothoracic shield, body, legs and prolegs black. Fourth abdominal segment has broad, greyish white saddle-mark, mid-dorsally divided by black stripe. All segments carry long, spiny, black tubercles.

Second-final instars (Figs. 4–6). Groundcolour remains unchanged. Tubercles fleshy, blunt, with broad base, black with the exception of the two light yellow dorsal ones on abdominal segment 4. The same segment carries a light yellow transverse stripe, which is dorsally as wide as the segment, laterally narrowing slightly down to spiracles. Some larvae have one or more additional lateral yellow spots on 3rd abdominal segment. Osmaterium light yellow. Measurements of a mature larva: Headcapsule, length 9.2 mm, width 8.6 mm, total length of larva 104.0 mm.

Pupa (Figs. 7–8). Groundcolour broadly yellow. Wingcases with brown base and small brown streak near apex. Thorax dark brown, tegulae and head yellow. Dorsally, between the wingcases, abdominal segments 1–6 have broad yellow saddle-mark with 2 black longitudinal lines. Abdominal segment 7 dark brown to

black, segment 8 dark ventrally, yellow dorsolaterally. Abdominal segments 6–9 each with 2 short, black processes.

The pupal period extended from 35 days to rather longer, depending on average temperatures of its habitat.

The pupa of *O. goliath* closely resembles that of *O. alexandrae*.

General Observations

Hostplant. As far as is known, *O. goliath* appears to be monophagous. Its host is a large *Aristolochia* species generally growing near running creeks in hilly country. Leaves resemble those of *A. tagala* but are shorter and thicker. Stems, when mature, are covered with thick layers of dry bark that produce a strong, pungent but pleasant odour when removed or scratched. Some old plants reach 20 or more meters up into the canopy of tall trees. In captivity 2 larvae were successfully bred on *A. tagala* (Womersley; Carver, pers. comm.).

Behaviour of larvae. The female butterfly deposits from one to several eggs on the hostplant, depending on its size. Young larvae feed on young leaves and tender shoots, gradually extending their feeding to older leaves and stems during their growth. Mature larvae, however, feed exclusively on mature, corky stems, severing these in several places, cutting off the upper parts from the roots and causing these parts to dry and perish.

It was observed in one instance that several larvae were devouring the same piece of stem resulting in it being cut into several lengths, some with one or more larvae at their ends, which fell to the ground where the caterpillars continued to devour it until little or nothing remained. Another larva was seen eating the base of what was left of the main stem down to the roots. By the time most larvae were ready for pupation, little remained of what was once a tall *Aristolochia* vine. In one instance a young larva was found on an isolated small hostplant, obviously too small to support the larva beyond its third instar (Pasternak, pers. comm.).

Unlike many other *Ornithoptera* species, *O. goliath* larvae do not wander far to pupate from where they were last feeding. For its pupation the larva generally selects the underside of a strong leaf of any kind of shrub growing near the remains of the *Aristolochia* hostplant and at a height varying from 0.5–3.0 m. above the ground, in a cool, shady position.

Predators. No predators have been observed on the larvae of *O. goliath*.

Adult behaviour. Although powerful fliers, the butterflies seldom leave their habitat. Mostly females are seen on the wing in their search for hostplants. However, both sexes can be seen feeding on flowering



FIGS. 1-2. *Ornithoptera goliath* Oberthur: (1) egg; (2) first instar larva.



FIGS. 3-4. *Ornithoptera goliath* Oberthur and *O. priamus poseidon* Doubleday:
(3) first instar larvae; (4) *O. goliath*, mature larvae destroying hostplant, *Aristolochia* sp.



FIGS. 5-6. *Ornithoptera goliath* Oberthur: (5) mature larvae destroying and (6) eating main stem of hostplant, *Aristolochia* sp.



FIGS. 7-8. Pupa of *Ornithoptera goliath* Oberthur: (7) latero-dorsal view; (8) lateral view.



FIGS. 9-10. Life stages of *Ornithoptera*: (9) *O. goliath* Oberthur. ♀ imago; (10) *O. chimaera* Rothschild, egg.



FIGS. 11-12. *Ornithoptera chimaera* Rothschild: (11) hostplant, *Aristolochia* sp., and (12) first instar larva, lateral view.



FIGS. 13-14. *Ornithoptera chimaera* Rothschild: (13) first instar larva, dorsal view; (14) fifth instar larva.



FIGS. 15-16. *Ornithoptera chimaera* Rothschild: (15) fourth instar larva attacked by parasites; (16) pupa, lateral view.



FIGS. 17-18. Pupa of *Ornithoptera chinazera* Rothschild: (17) lateral view; (18) dorsal view.



FIGS. 19-20. Imago of *Ornithoptera chimaera* Rothschild: (19) ♂, freshly emerged; (20) ♂, wings spread.

trees in the forest or on the orange-red flowers of the introduced African Tulip Tree, *Spathodea campanulata*, where it grows in or near the edge of the forest. Males of *O. goliath* were observed several times being chased over long distances by males of *O. priamus poseidon*. Often the former tried to escape by rising high above the treetops, folding their wings and diving down to about tree level. If *O. p. poseidon* males made contact, they attacked with outstretched legs. Some captured *O. goliath* males showed damage, generally to the hindwings as tiny notches and holes, possibly caused by the sharp tarsal claws of the *O. p. poseidon* males. Females were not attacked. Both sexes were seen actively feeding during early morning hours until about 0930. During the warmer hours males were seen resting with folded wings, when the peculiar underside coloration made them nearly invisible against the foliage. Females rested with wings spread. Largest number of eggs counted in a female was 20, including immature eggs.

Ornithoptera chimaera chimaera Rothschild

This species (Figs. 19, 20) is widely distributed over the highlands of the whole mainland of New Guinea at altitudes ranging from 1600–2800 m. Adults are sometimes seen feeding on flowering trees, mainly during the dry season (June–October). The early stages are generally hard to find, although the foodplant (*Aristolochia* sp., Fig. 11) is found in many areas. For their oviposition the females generally choose habitats in steep mountain gorges and ridges where the hostplant grows in dense vegetation in damp, cold conditions. Such places are often difficult to reach.

Early Stages

Egg (Fig. 10). Large, diameter 4.0 mm. Colour light yellow. When deposited, covered with bright orange-yellow substance, sticking it firmly to the rough underside of a mature leaf of the hostplant. Incubation period long, from 14 days onwards, depending on average temperatures of its habitat.

First instar larva (Figs. 12–13). Groundcolour reddish black. Head, prothoracic shield, legs, and spiny tubercles black except fleshy base of the 2 dorsal tubercles of 4th abdominal segment which is yellow.

Second-final instars (Fig. 14). Groundcolour varies from reddish black to black. Tubercles fleshy, black, the 2 dorsal ones on abdominal segment 4, yellow or sometimes partly or faintly yellow tipped (this depends on localities). Osmaterium bright yellow. Measurements of a mature larva: Length 94.0 mm, headcapsule length 8.1 mm, width 7.7 mm.

Pupa (Figs. 16–18). Groundcolour dark brown to black. Colour of wingcases varies from black to dark yellowish mottled brown, except for a yellow base extending to about $\frac{1}{4}$ of the wingcase length. Head, thorax and ventral parts of abdominal segments black. Tegulae black with a bright, narrow, orange-yellow disk. Saddlemark yellow but broadly divided middorsally, extending laterally on abdominal segments 1–5 forming broad yellow spots, increasing in size caudad and

reaching greatest width on segments 3 and 4, where it is crossed by a black stripe.

The yellow area ends on segment 5 where it is triangularly shaped and reaches halfway down this segment.

Abdominal segment 6 dark brown to black, segments 7-9 each carry a broad, dorsal, orange-yellow spot, which is middorsally divided by black stripe, and yellow area latero-dorsally. Crenaster orange-yellow dorsally, black ventrally. Latero-dorsally the abdominal segments 6-9 carry 2 sharp, black spines each. Pupal period long, depending on average temperatures of habitat, from 7-10 weeks or longer.

General Observations

Behaviour of larvae. Young larvae feed on tender leaves and shoots, mature ones mainly on old leaves and parts of the stems. Shortly before pupation the larva chews some bark from the main stems but otherwise does not cause additional damage. *O. chimaera* larvae often walk a long distance away from where they have been feeding last, in their long search for a suitable pupation site. In one instance it took a larva five days of restless wanderings before it finally settled down for pupation (Pasternak, pers. comm.). Average height of pupa above the ground 1-4 m. Longest distance recorded from hostplant where pupa was located: nearly 20 m.

Predators. In some areas an estimated 30% or more of fourth instar larvae perish after being attacked by parasites (Braconidae, *Apanteles* sp. *vitripennis* group?) (Fig. 15). The occurrence of these parasites appears to be local, or may be seasonal as in some habitats none or very few larvae were attacked. In some instances, where more than one larva was present on the same hostplant, the smallest were attacked and devoured by the stronger specimens. This cannibalistic behaviour does not appear to be the general rule.

ACKNOWLEDGMENTS

Thanks are due to Mr. Ted Fenner, Entomologist, Department of Agriculture, Konedobu for critically correcting and improving this manuscript, and to Mrs. D. Bowden and Mrs. R. Carr, Sogeri, for typing this paper. Dr. D. Frodin, University of Papua-New Guinea, kindly identified plant specimens.

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OECOPHORIDAE FROM WEST TEXAS

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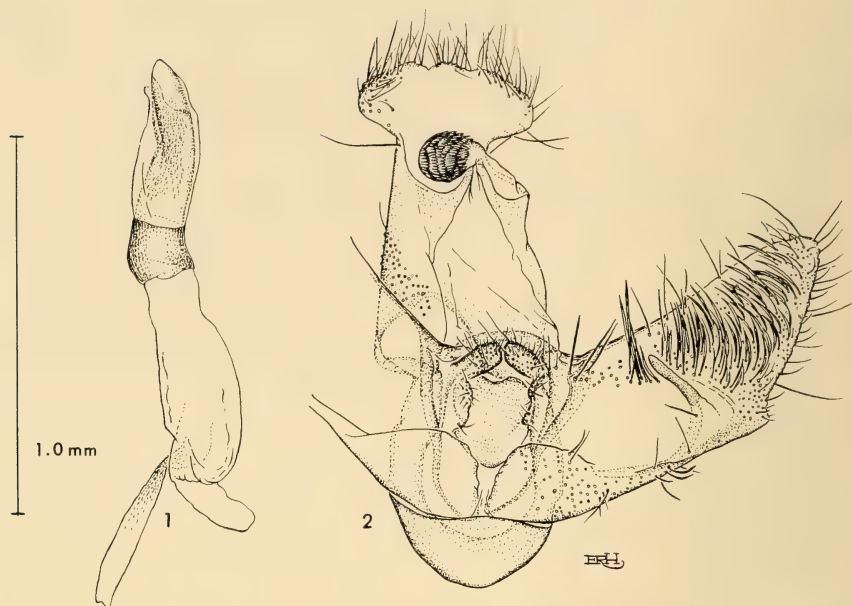
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André and May Elise Blanchard, Doug Ferguson, and I collected moths in the Guadalupe Mountains, Sierra Diablo, and Chisos Mountains and at Shafter in western Texas during late May and early June 1973. Collecting for microlepidoptera was excellent, and gelechioids were particularly abundant. Because I had recently revised the Oecophoridae for the *Moths of America North of Mexico*, I was interested in all Oecophoridae to learn more about geographic distribution of species and faunal composition for this region. During this period six species were collected: two were anticipated, two were new species, and two represented major range extensions from the East. Data and comments on these species follow.

***Agonopterix hesphoea* Hodges, new species**

Figs. 1-2, 6

Agonopterix hesphoea is a small yellowish-gray and brown moth with upper surface as illustrated (Fig. 6). Head: tongue pale yellowish white; base of maxillary palpus dark brown, apex yellowish white; individual scales on frons dark gray basally, pale gray apically, dark gray to nearly black scales in front of eye; vertex and occiput yellowish orange, scales tipped with pale gray; a row of dark gray scales tipped with pale gray behind eye; labial palpus with inner surface of first segment yellowish white, outer surface mainly yellowish white with black scales near anterior margin, second segment mottled pale yellowish gray and dark gray, all scales tipped with pale gray, anterior surface mainly dark gray, scales with pale gray apices, inner surface pale yellowish white basally becoming mottled with dark gray on anterior margin to apex, third segment slightly darker than second segment with a poorly defined annulus at base and an intense one at apex; antenna $\frac{1}{2}$ to $\frac{3}{5}$ length of forewing, shaft somewhat stout and greasy dark gray brown, scape dark gray, pecten contrastingly pale yellowish gray. Thorax pale orange brown, scales tipped with pale gray, apex of mesothorax dark gray to black. Forewing: scales mottled orange brown, yellowish gray, pale gray and dark gray, most scales tipped with pale gray; a pair of offset black spots at $\frac{2}{3}$ length of cell and a few white scales at end of cell; ventral surface mainly dark gray, costal margin barred with alternating zones of dark gray and pale yellowish gray; base of fringe pale yellowish gray to orange gray, rest of fringe darker gray but scales tipped with pale gray. Hindwing: shining gray with some yellowish or orange reflections; a tuft of scales from base of anal veins; base of fringe pale yellowish gray and contrasting with gray scales on wing, a row of medium gray tipped scales at base of fringe followed by a longer row of paler gray scales; ventral surface mainly medium to dark gray, anterior part mottled with some pale gray scales, margin of wing from apex toward tornus with dark gray scales. Foreleg: mottled dark gray and pale yellowish gray, individual scales tipped with pale gray, apex of coxa and base of femur pale, extreme apices of tarsal segments pale yellowish gray. Midleg: much as for foreleg but with more pale yellowish gray scales; tibia with strong medial and apical



Figs. 1, 2. Male genitalia of *Agonopterix hesphoea*: 1, aedeagus; 2, posteroventral view of genitalia with aedeagus removed.

scale tufts, tibial spurs dark gray basally becoming pale yellowish gray distally; tarsus with apices of segments yellowish to orange gray, ventral surface orange gray to orange brown. Hindleg: paler than midleg; tibia with series of long slender scales on dorsal surface. Wing length 8.7 mm. Male genitalia: as illustrated (Figs. 1, 2): valva almost truncated on saccular margin, sacculus sclerotized to apex, process on inner surface extending to $\frac{3}{4}$ width of valva; gnathos short, broadly ellipsoidal; uncus-socii with three parts indistinguishable. Female: no specimens available.

The immature stages are unknown.

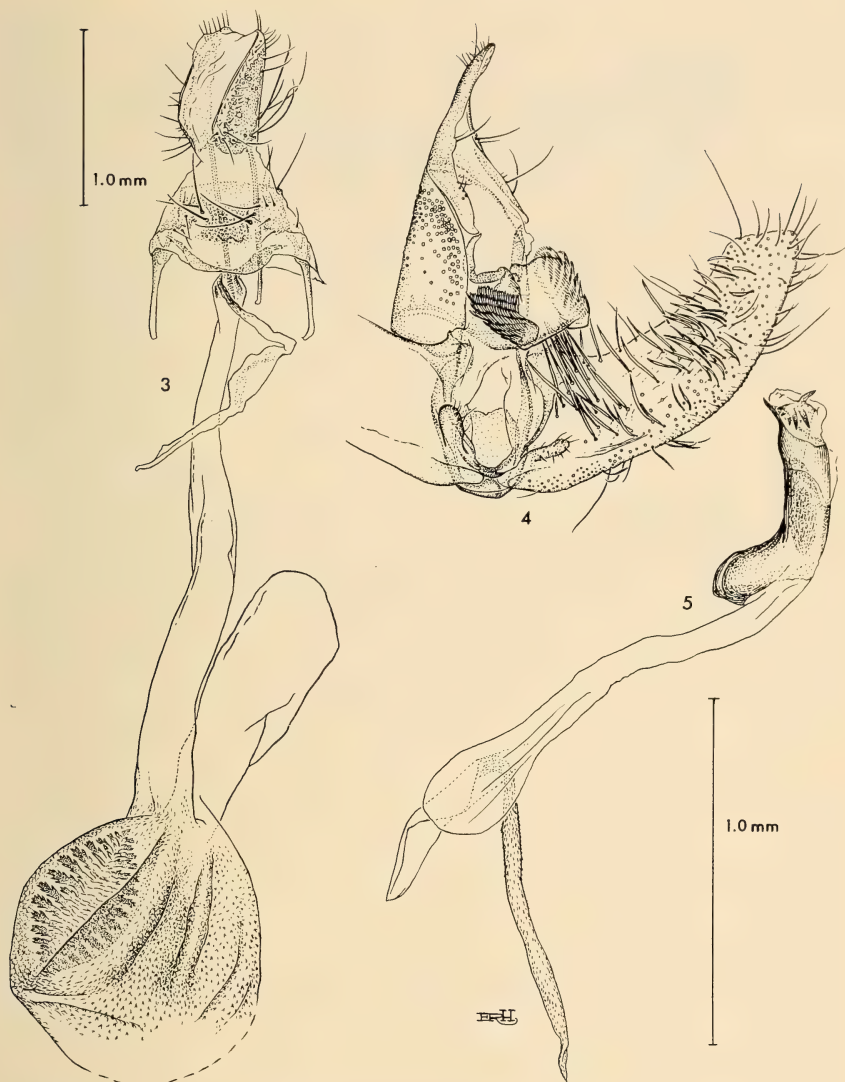
Holotype: ♂. Texas, Culberson Co., Sierra Diablo 20 mi. NNW Van Horn, 6000 ft.; 27 May 1973; R. W. Hodges; USNM genital slide 4653. USNM type number 73061.

Agonopterix hesphoea is superficially much like *A. psoraliella* (Wlsm.). *Agonopterix hesphoea* has the base of the fringe pale yellowish gray and contrasting with the medium gray hindwing, whereas in *psoraliella* the base of the fringe is gray and slightly darker than the hindwing. The free process on the inner surface of the valva is half the width of the valva in *hesphoea*, longer than the width of the valva in *psoraliella*: the gnathos is short and broadly ellipsoidal in *hesphoea*, long, slender and with an acute apex in *psoraliella*.

Psilocorsis quercicella Clemens

Proc. Acad. Nat. Sci. Philadelphia, 212, 1860.

Chisos Mountains, Panther Pass, 6000 ft. elevation, 2 June 1973, 1 ♂, 1 ♀.



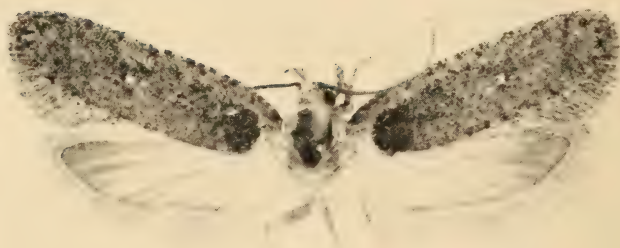
Figs. 3-5. Genitalia of *Psilocorsis fatula*: 3, ventral view of female; 4, postero-ventral view of male with aedeagus removed; 5, aedeagus.

These are the westernmost records for *quercicella* which had previously been known from eastern Texas and northwest Arkansas to the East Coast (Hodges, 1974).

***Psilocorsis fatula* Hodges, new species**

Figs. 3-5, 7

Psilocorsis fatula is a pale yellowish brown moth with upper surface as illustrated (Fig. 7). Head: tongue and maxillary palpus pale yellowish white; ventral margin



6



7

Figs. 6, 7. Upper surfaces: 6, *Agonopterix hesphoea*, holotype ♂; 7, *Psilocorsis fatula*, holotype ♀.

of frons naked, rest pale yellowish gray; vertex and occiput pale yellowish brown, darker than frons; labial palpus mainly yellowish gray, anterior surface of second and third segments with a black line bordered on each side by a row of yellowish white scales, third segment with a second and third row of black scales on lateral and mesal surfaces; scape of antenna mainly pale yellowish brown, anterior margin with a yellowish white line bordered dorsally and ventrally by black scales, shaft with continuation of color pattern of scape to half or $\frac{3}{4}$ length of antenna and with a third row of black scales on posterior surface, antenna yellowish gray distally. Thorax: dorsal surface of pro- and mesothorax slightly darker than vertex and occiput. Forewing: shining yellowish brown with numerous, transverse brown flecks best developed on costal margin; six black spots on outer margin from apex to tornus; a series of black scales at end of cell; fringe on outer margin with basal row of shining dark gray scales followed by row of paler shining gray scales. Hindwing: shining pale yellowish white, becoming slightly more yellow at apex, a few dark gray to black scales on outer margin at apex and posterad of apex, ventral surface mainly pale yellowish brown with numerous dark gray scales on cell, area posterad of fold paler than rest of wing. Foreleg: coxa yellowish white; femur darker yellowish white to yellowish brown, apex yellowish white; tibia mainly

yellowish brown, scales on epiphysis yellowish white; tarsus yellowish brown with some gray scales on fourth and fifth segments. Mid- and hindlegs: much as for foreleg but slightly paler, stout setae on tarsi brown, fourth and fifth tarsal segments darker than preceding tarsal segments. Abdomen: dorsal surface shining pale yellowish white, paler laterally; ventral surface darker than dorsal surface. Wing length 8–9 mm. Male genitalia: as illustrated (Figs. 4, 5): valva with costal and saccular margins somewhat parallel basally, distal margin nearly straight; lobes of juxta half basal width of valva; aedeagus with four stout cornuti, angulate at basal $\frac{2}{3}$; an eversible tuft of scales from first and second abdominal sterna. Female: as illustrated (Fig. 3): ostium bursae near anterior margin of eighth abdominal sternum, preceded by narrow sclerotized band; extreme base of ductus bursae heavily sclerotized; ductus seminalis arising from slightly bulbous base of ductus bursae; basal $\frac{2}{3}$ of ductus bursae lightly sclerotized, distal $\frac{1}{3}$ more heavily sclerotized, ductus bursae approximately twice length of corpus bursae; walls of corpus bursae heavily spiculate, accessory pouch arising from base of corpus bursae; signum elliptical with pointed ends, 15–18 branches on each side; eighth sternum with pair of strong, sublateral setae; eighth tergum with row of long setae on posterior margin; papillae anales heavily sclerotized but membranous just before heavily sclerotized ventral margin.

The immature stages are unknown.

Holotype: ♀. Texas, Culberson Co., Guadalupe Mountains, Smith Canyon, 5750 ft.; 22 May 1973; R. W. Hodges; USNM genital slide 4650. USNM type number 73060. **Paratypes:** 8 ♂♂, 1 ♀. Same data as for holotype (4 ♂♂). Texas, Culberson Co., Guadalupe Mountains, Cherry Canyon, 5096 ft.; 22 May 1973; R. W. Hodges (1 ♂). Texas, Brewster Co., Chisos Mountains, Panther Pass, 6000 ft.; 2 June 1973; R. W. Hodges (1 ♂). Texas, Guadalupe Mountains, Smith Canyon; 22 May 1973; A & ME Blanchard (1 ♂). Texas, Guadalupe Mountains, Frijoles; 24 May 1973; A & ME Blanchard (1 ♀). New Mexico, Las Vegas Hot Springs; on leaf of oak; July 11; Cockerell (1 ♂).

In the short type series variation is limited to wing length, hue of the forewing, and overlay of brown transverse marks.

Psilocorsis fatula is typical of the genus and can be separated from the other species by the combination of indistinct transverse marks on the forewing and pale yellowish-gray to yellowish-white hindwing. The male and female genitalia ally *fatula* with *arguta* Hodges, but *arguta* has darker forewing color with intense transverse flecks and medium gray hindwings.

I have seen additional specimens of *fatula* from Ruidoso Canyon and Las Vegas Hot Springs, New Mexico.

Durrantia piperatella (Zeller)

Verh. k.-k. zool.-bot. Ges. Wien, 23: 239, 1873.

Chisos Mountains, Green Gulch, 5500 ft. elevation, Panther Pass, 6000 ft., 2, 6 June 1973, 5 ♂♂. *Durrantia piperatella* is known from northwest Arkansas to the Davis Mountains in western Texas (Hodges, 1974).

Inga concolorella (Beutenmüller)

Ent. Americana, 4: 30, 1888.

Shafter, 4000 ft., 31 May 1973, 1 ♂. I (1974) recorded *concolorella* from Las Cruces, New Mexico to the West Coast. This is a state record for the species but an anticipated one.

Carolana ascriptella (Busck)

Can. Ent., 40: 194, 1908.

Sierra Diablo, 6000 ft., 29 May 1973, 2 ♂♂. These two specimens are a state record for *ascriptella* but more importantly represent a western extension into the mountains. Earlier (Hodges, 1974) *ascriptella* had been recorded from New Hampshire and Washington, D.C. to northwest Arkansas.

ACKNOWLEDGMENTS

I express thanks to the following: the personnel of Big Bend National Park, Guadalupe National Park, and the Texas Park and Wildlife Department, particularly of the Sierra Diablo Wildlife Management Area; Mr. Blanchard, who showed me many excellent collecting sites and allowed me to sort through his light trap catches for small moths; the Photographic Services Unit of the Smithsonian Institution, that made the photographs of the moths; and my wife, Elaine R. Hodges, who made the line drawings.

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TWO NEW IOWA RECORDS

During field work for a larger project on the butterflies of Iowa, two species were collected whose occurrence in the state has not heretofore been reported. Population samples repeated over two and three year intervals indicate established residency in contrast to casuals and temporary resident status.

Glaucopsyche lygdamus couperi Grote was first taken on Hayden Prairie, Howard Co., Iowa, 28 May 1972 in considerable numbers. Populations were subsequently noted and samples collected in western Iowa on Cayler Prairie, Dickinson Co., 6 June 1973 and 5–12 June 1974. The species was also found at Fort Defiance State Park, Emmet Co., 6 June 1973.

Breeding populations of *Coenonympha inornata benjamini* McD. were located in Gitchie Manitou State Park, Lyon Co., Iowa, 12–13 June 1973 and again on 12 June 1974. All of the Iowa localities above are in the northern tier of counties.

Both of these species have been reported in restricted localities in more northern states including South Dakota, Minnesota and Wisconsin. In addition, *lygdamus* occurs in Illinois, Missouri, Kansas and Nebraska, so that Iowa records are not unexpected. It is assumed that the association of both species with prairie remnants in the Iowa localities mentioned, helps account for the paucity of records. Native prairie refugia have dwindled to less than 600 widely scattered acres within the state; the Hayden and Cayler Prairie sites represent two of the three largest remaining tracts. In my opinion the two butterfly species have been overlooked by collectors rather than the sites recently colonized by the insect.

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A NEW PHYCITINE GENUS AND SPECIES (PYRALOIDEA)

ANDRÉ BLANCHARD

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Atopothoures A. Blanchard, **new genus**

Head (Fig. 4): Labial palpus porrect, second segment slightly ascending, exceeding front by almost $1\frac{1}{2}$ eye diameters, first segment short, third segment not quite as long as second. Maxillary palpus minute, squamous. Tongue very short, very thin, thinly scaled at base, showing between labial palpi, but not separating them. Male antenna (Fig. 6) ciliate, a shallow sinus at base, in what appears to be several fused segments, is bordered by two rows of long scales. Female antenna simple, shortly ciliate.

Forewing (Fig. 8): eleven veins; cell about $\frac{3}{5}$ length of wing; Sc free; R_1 from cell; R_2 from cell, connate or closely approximate to R_{3+4} ; R_5 stalked with R_{3+4} , the stalk about the same length as the free part of R_{3+4} ; M_1 free, straight; M_2 and M_3 stalked for about $\frac{1}{3}$ their length; Cu_1 from lower outer angle of cell; Cu_2 from before angle.

Hindwing (Fig. 9): Sc and Rs anastomosed for about $\frac{1}{2}$ the length of Rs; M_1 from upper angle of cell, remaining closely approximate to the stalk of Sc and Rs for about $\frac{1}{4}$ its length; M_2 missing; M_3 and Cu_1 stalked for about $\frac{1}{2}$ their length; Cu_2 from before lower outer angle of cell.

Male genitalia (Fig. 5): On each side of the bifid uncus and adnate to the tegumen, a sclerotized triangular flap which does not appear to be part of either, but to be attached to both by thin membranes. Gnathos bridging opposite bases of the tegumen, culminating in a flanged process, the lobes of which fuse posteriorly. Juxta lightly sclerotized. Transtilla absent. Vinculum broad, short. Valves subquadrate, simple. Aedeagus stout, flared at base. Vesica unarmed.

Female genitalia (Fig. 7): no sclerotization at genital opening; bursa copulatrix without signum; ductus seminalis from ductus bursae near its junction with bursa.

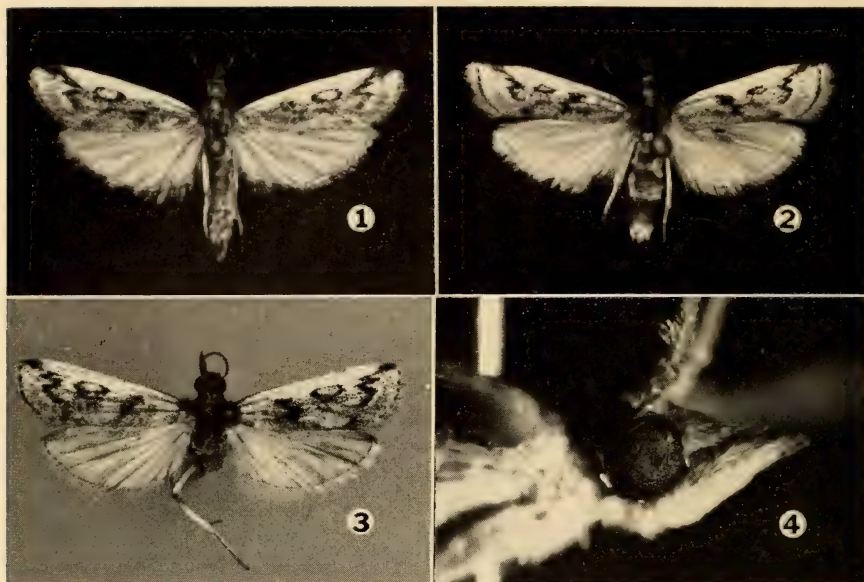
The male genitalia of this new genus are unlike anything in Heinrich's monograph (1956). The triangular flaps on each side of the uncus appear unique and their homology is unclear to me. There are several phycitine genera with a similar venation, but the extreme reduction of the tongue and the several fused segments of the male antennae seem to indicate some affinity with the genera which were classified as *Anerastiinae* before J. C. Shaffer (1968) transferred them to the *Phycitinae*.

Atopothoures ovaliger A. Blanchard, **new species**

Figs. 1-9

Head: Vertex and front light yellowish brown; palps concolorous, except that first and second segments are whitish beneath. Thorax concolorous with head above, white beneath.

Forewing above: Costal half white, with a sprinkling of orange to red scales, varying from light (mostly in males) to heavy (mostly in females), always much heavier basally and sometime along costa; terminal area and area between cell and inner margin gray, darker; antemedial band not traceable between costa and radial vein, obscure between radial vein and inner border, defined chiefly by an outwardly lying patch of blackish scales, much darker in cell and fold; a black shade



Figs. 1-4. *Atopothoures ovaliger*: 1, ♂ holotype, Junction, Texas, 21 Aug. 1973; 2, ♂ paratype, San Antonio, Texas, 30 Aug. 1973; 3, ♂ paratype, San Antonio, 9 Sept. 1971; 4, head of ♂ paratype, San Antonio, 30 Aug. 1973.

extending from apex, obliquely inward across the subterminal band; subterminal band a faint, pale line inwardly bordered by a strong black line, retracted in front of cell, with a deeper indentation in the fold; on the better marked specimens the discocellular dots are represented by an elliptical spot, outlined in black, with a pale inner area; this spot is extremely variable in size, from about $\frac{1}{3}$ the distance between medial lines to a single small black spot; terminal line of confluent, inter-venular, black dots; fringes whitish.

Hindwing above: White with a creamy or smoky tint; a faint brownish line along termen; fringe paler.

Both wings beneath: Fuscous with a blackish line along termen.

Wing expanse: Males 15.0-20.0 mm; females 18.0-20.5 mm.

Abdomen: Light fuscous above, darker gray beneath.

Male genitalia: As described for the genus. See Fig. 5.

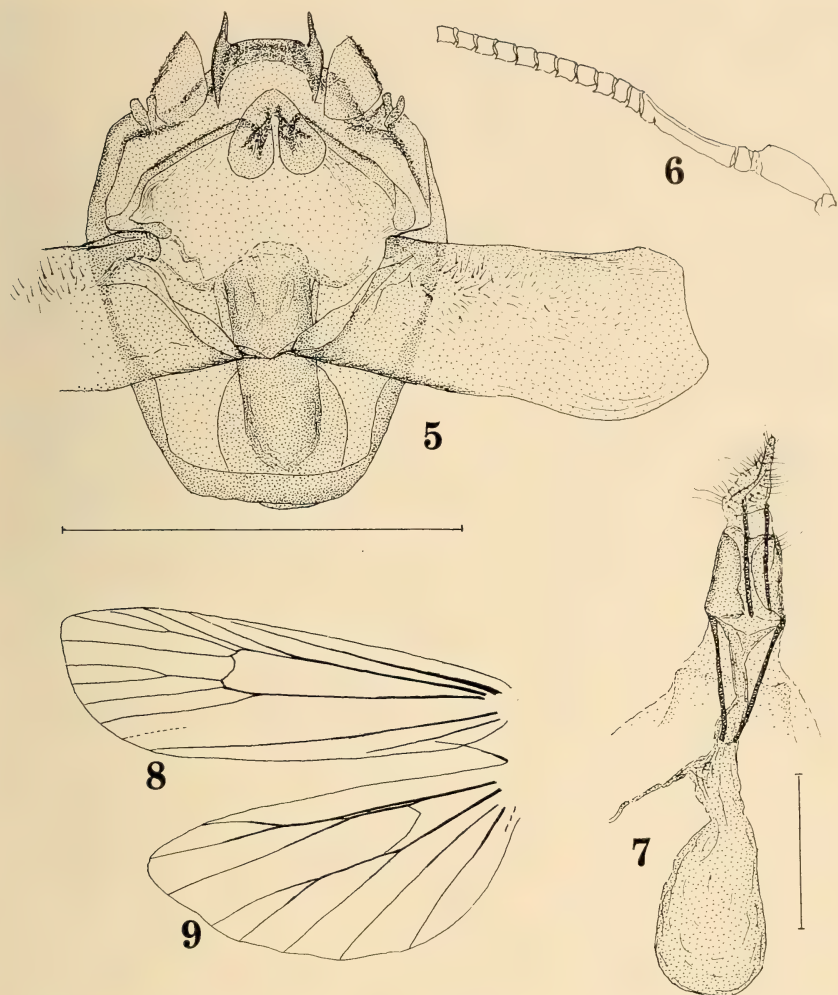
Female genitalia: As described for the genus. See Fig. 7.

Life history: Unknown.

Holotype: Male, Junction, Texas, 21 Aug. 1973, deposited in the National Museum of Natural History (No. 73241).

Paratypes: San Antonio, Texas, Mountain View Acres (Roy Kendall's Ebony Hill Station), 9 Sept. 1971, one ♂; Artesia Wells, Texas, Chaparral Wildlife Management Area, 28 Sept. 1971, one ♂; Junction, 21-24 Aug. 1973, nine ♂♂, six ♀♀; San Antonio, Texas, 30 Aug. 1973, seven ♂♂.

There is in the National Museum one male specimen, from San Benito, Texas, (July 16-23) of which I prepared the genitalia and the right pair of wings (slide U.S.N.M. 52417) which obviously belongs to this new genus and appears to be very close to, although not conspecific with,



Figs. 5-9. *Atopothoures ovaliger*: 5, ♂ genitalia, slide A. B. 3086, Junction, Texas, 24 Aug. 1973; 6, basal segments of ♂ paratype antenna, slide A. B. 2777; 7, ♀ genitalia, slide A. B. 3183, Junction, 21 Aug. 1973; 8-9, forewing and hindwing venation of a ♂ paratype, slide A. B. 2777, San Antonio, 9 Sept. 1971.

ovaliger. In agreement with Dr. D. C. Ferguson it was decided to wait until more material becomes available to describe it.

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A NEW SCHOENOBINE GENUS AND SPECIES (PYRALOIDEA)

ANDRÉ BLANCHARD

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Carectocultus A. Blanchard, new genus

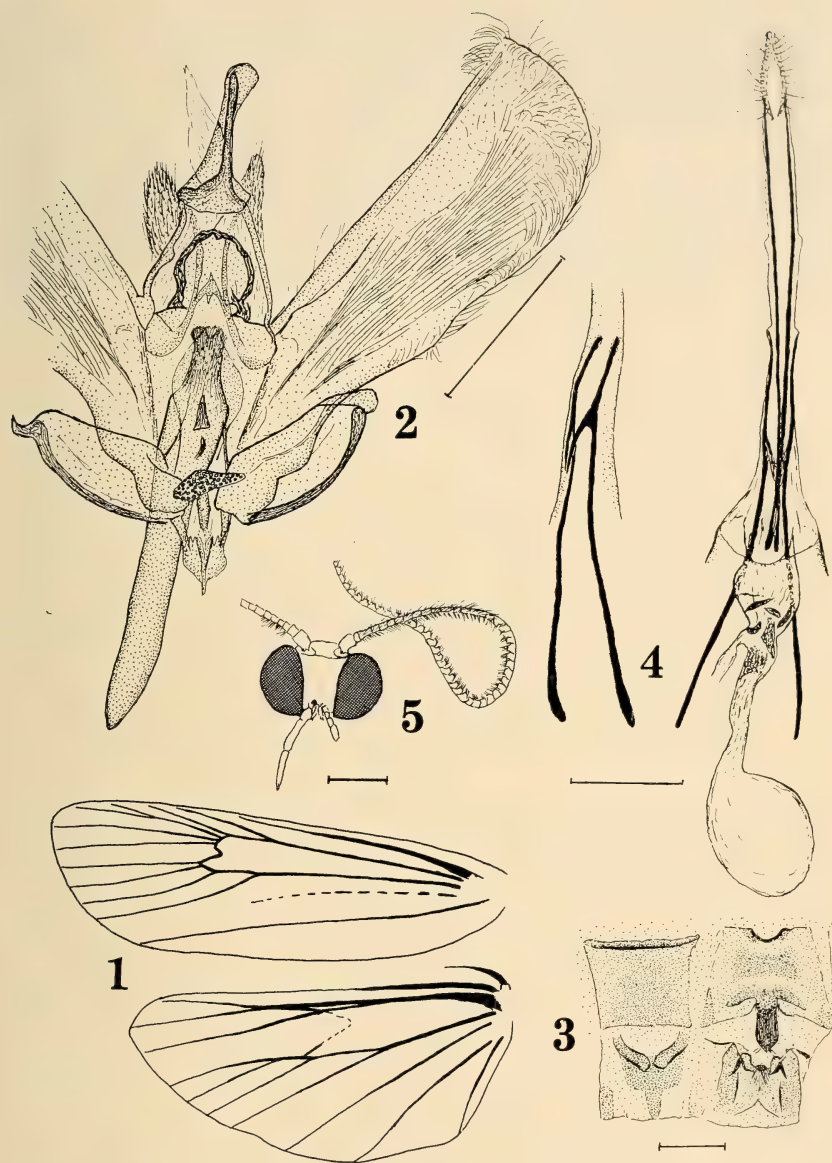
Head (Fig. 5): Eyes bulging, slightly larger in diameter than height of head. Front rounded, about $\frac{1}{2}$ an eye diameter wide. Tongue short. Labial palps porrect, slightly downcurved, clothed with long scales, exceeding front by about one eye diameter, second segment longest. Maxillary palps about $\frac{1}{2}$ as long as labial palps, triangularly tufted. Male antennae clothed with scales dorsally and dorsolaterally, ciliate; length of bristles slightly larger than diameter of shaft. Female antennae thinner, pubescent.

Thorax: Legs long; with femur folded alongside coxa and tibia alongside femur, the male's hindlegs exceed the tip of abdomen by the four distal segments of the tarsus; female's hindlegs shorter, only reach tip of abdomen. Forewing (Fig. 1): cell $\frac{3}{4}$ the length of wing; Sc well separated from radius; R_1 and R_2 from cell; R_3 and R_4 stalked over $\frac{1}{2}$ the length of R_4 ; M_2 and M_3 separately from lower outer angle (or rather bend) of cell; Cu_1 from before the bend; Cu_2 from well basad of Cu_1 ; basal half of first anal is at most a shadow on a stained wing preparation but nothing remains of the distal half. Hindwing (Fig. 1): cell about $\frac{1}{2}$ as long as wing; discocellular vein deeply angled-in; Rs anastomosed with Sc over a short length but leaving upper outer angle of cell separately; M_1 connate with Rs; M_2 and M_3 shortly stalked from lower outer angle of cell; Cu_1 from near angle; Cu_2 from cubitus $\frac{2}{3}$ distance from base.

Male genitalia (Figs. 2 & 3): Uncus spatulate, enlarged at base. Gnathos thin, nearly as long as uncus, enlarged at base, forming with uncus a mandibulate assembly. Long, flaplike, ciliate socii on each side of the tegumen. Valves long, broadest $\frac{2}{3}$ distance from base, deeply striated from base to apex, except along costa and sacculus. Transtilla shaped like a horseshoe, heavily sclerotized. Juxta narrow, long. Vinculum narrowing progressively towards short saccus. Attached and articulated to vinculum on each side of it, cephalad from the valve, there is a small spoon-like appendage, clothed with bristle-like scales. Between these appendages and narrowly connected to vinculum, there is a small plate covered with bouquet of long, subparallel, bristle-like scales. Aedeagus as long as combined length of vinculum and tegumen, dilated in distal $\frac{1}{3}$ – $\frac{3}{4}$ and constricted at apex. Vesica with some darkened, probably sclerotized wrinkles, armed with one cornutus. Eighth abdominal segment with sclerotized plates; seventh segment with a medial scale tuft.

Female genitalia (Fig. 4): Corpus bursae bulbous, without signum; ductus bursae about twice as long as diameter of corpus bursae, unsclerotized except in the $\frac{1}{4}$ – $\frac{1}{2}$ of it, between origin of ductus seminalis and pouch-like ostium bursae, where there are three or four small sclerites; depth and breadth of ostium bursae about three times diameter of ductus bursae. Anterior apophyses as long as combined length of corpus, ductus and ostium bursae; connected together at $\frac{1}{4}$ their length from their caudal extremity by a V-shaped bridge. Posterior apophyses $1\frac{1}{2}$ times as long as anterior apophyses. Ovipositor laterally compressed, blade-like.

The new species of Schoenobiinae, the description of which follows, looks so much like *Scirpophaga perstrialis* Hbn. that I first thought that they would fit nicely into the same genus. The examination of the genitalia did not change too much this opinion, since the most obvious



Figs. 1-5. *Carectocultus dominicki*: 1, male wing venation; 2, male genitalia; 3, sclerotization of seventh and eighth abdominal segment of male; 4, female genitalia and dorsolateral view of anterior apophyses; 5, denuded head of a male specimen.

difference between the male genitalia is in the shape and degree of sclerotization of the transtilla (very little sclerotization in *perstrialis*); the difference between female genitalia is mostly a matter of the length of the collar and ovipositor apophyses, which are much shorter in *perstrialis* than in the new species. I would probably have decided to describe the new species as a *Scirpophaga* if I had not become suspicious of the proper classification of *perstrialis* in *Scirpophaga*, which is a European genus. The British Museum (Natural History) let me have a pair of *Scirpophaga praelata* Scopoli for dissection. The examination of wing venation and genitalia of that pair left me with absolutely no doubt: neither *perstrialis* nor the new species can fit under *Scirpophaga*. The differences between female genitalia, particularly, are definitely irreconcilable: at least one new genus was needed. I did not try to make the description of it broad enough to cover both species, as I have some doubts that they are congeneric.

Forbes (1923; p. 525), in his characterization of the Schoenobiinae, writes about the venation of the forewing: "1st. A a developed tubular vein at margin, with interspaces of the normal width between it and the veins above and below it; usually curving down to inner margin." This character, which he uses in his key to the subfamilies of the Pyralidae, would eliminate "*Scirpophaga*" *perstrialis* as well as the new species although I have no doubt that they are true Schoenobiinae.

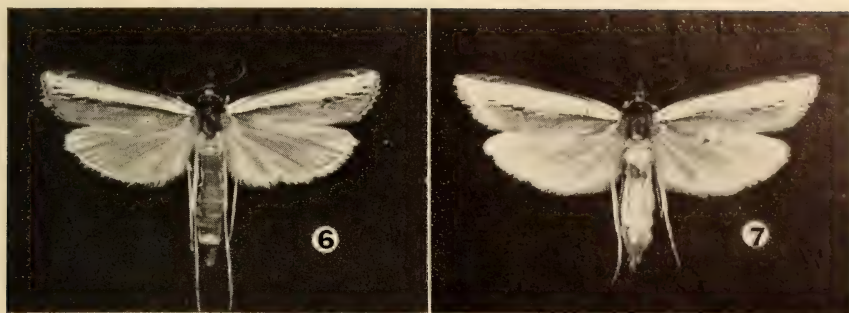
Carectocultus dominicki A. Blanchard, new species

Figs. 1-7

Male (Fig. 6): Maxillary and labial palps above dark brown; labial palps beneath white. Front and vertex brown, some white scales behind antennae and eyes. Collar and tegulae brown; thorax darker. Forewing above: a silvery white fascia, between radius and cubitus, extends almost to the outer margin, becoming three-pronged over R_5 , M_1 and M_2 because of thin intervenular brown dashes. More intervenular short dashes between M_2 , M_3 and the cubital veins. Lower half of wing becomes progressively paler and duller toward the inner margin. No antemedial line. The white subterminal line starts on costa $\frac{1}{6}$ – $\frac{1}{4}$ wing length from apex, can be traced even through the white fascia, because of the intervenular dashes adnate to and basad of it; it approaches to within about $\frac{1}{15}$ wing length of the termen over vein M_1 , then is deeply drawn in and becomes subparallel to the fascia; at a point about $\frac{2}{3}$ wing length from base it makes a sharp turn toward inner margin and disappears completely before reaching second anal vein; adterminal line of confluent intervenular blackish dots. Terminal line white. Fringe brown, more or less checkered. A small brown spot on discocellular vein. Hindwing above: smoky tan; intervenular darker dots at termen; fringe slightly paler than disk of wing. Wings beneath: brownish; forewing darker except under white fascia; terminal lines and fringes as above. Abdomen above smoky tan, almost black at the tip; beneath yellowish tan.

Female (Fig. 7): Same pattern of wing maculation as male, but much paler generally. Abdomen white. Hind wings white.

Wing expanse: Male 24.0–29.5 mm, average 27.5 mm; female 28.0–33.0 mm, average 30.5 mm.



Figs. 6-7. *Carectocultus dominicki*: 6, holotype, male, Deutschburg, Jackson Co., Texas, 31 July 1972; 7, paratype, female, Deutschburg, 31 July 1972.

Male genitalia: As described for the genus and shown in Figs. 2 & 3.

Female genitalia: As described for the genus and shown in Fig. 4.

Holotype: Male, Deutschburg, Jackson Co., Texas, 31 July 1972, deposited in National Museum of Natural History (No. 73242).

Paratypes: Ocean City, Okaloosa Co., Florida, 17 May 1962, 1 ♀, collected by H. O. Hilton. The Wedge Plantation, McClellanville, South Carolina, 8 June 1971, 1 ♂; 17 June 1971, 1 ♂; 19 June 1971, 1 ♀; 21 June 1971, 2 ♂♂, 2 ♀♀; 26 July 1971, 1 ♀; 28 July 1971, 1 ♂; 30 July 1971, 1 ♀; 31 July 1971, 1 ♂; 2 Aug. 1971, 1 ♀; 9 Aug. 1971, 3 ♂♂; 10 Aug. 1971, 1 ♂, 1 ♀; 19 Aug. 1971, 1 ♂; 30 June 1973, 1 ♀; 2 July 1973, 1 ♀, collected by R. B. Dominick. Deutschburg, Jackson Co., Texas, 31 July 1972, 4 ♂♂, 11 ♀♀; 2 Aug. 1972, 9 ♂♂, 4 ♀♀; 18 Sept. 1973, 1 ♂.

Paratypes are deposited in the National Museum of Natural History, in the British Museum (Natural History), in the Canadian National Collection and in the American Museum of Natural History.

This species is dedicated to Dr. Richard B. Dominick, to whom we owe the publication of the magnificent *Moths of America North of Mexico*, who has collected large numbers of this insect, and who gave me (in litt.) the following information: "Data from the Wedge series of about 150 specimens (all caught at U.V. light) show records beginning just barely in May, ending in September; predominantly in July and August. It would seem to indicate two broods, late June through early July, and then again late July through August . . . a gentle curve with two gentle peaks, beginning May, ending September."

ACKNOWLEDGMENTS

It is a pleasure to acknowledge with thanks the gift of a pair of *Scirpophaga praelata* Scopoli by the British Museum (Natural History) and the loan of specimens by Dr. R. B. Dominick and Mr. H. O. Hilton.

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A NEW SPECIES OF *MELITAEA* (NYMPHALIDAE) FROM ARMENIA

YURI P. NEKRUTENKO

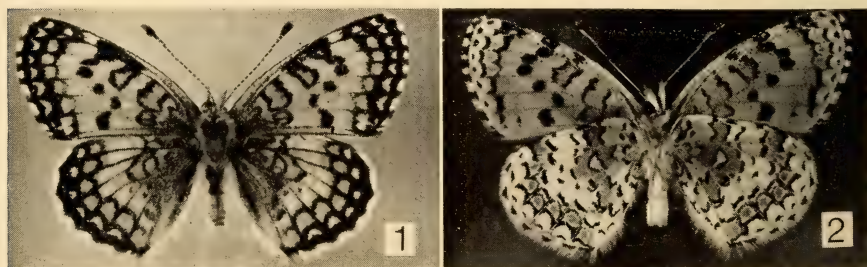
Ukrainian Research Institute for Plant Protection,
33 Vasilkovskaya Street, Kiev 127, Ukraine 252627, U.S.S.R.

While a member of the State Museum of Georgia Transcaucasian Expedition, I collected in the Chosrov Wildlife Reservation (Armenia), where an undescribed fritillary species of the *phoebe*-group was found. This is thirtieth species of *Melitaea* (s. str.) known to occur in the U.S.S.R. territory, and ninth in the Caucasus Range (Korshunov, 1972). In the description of this new species I follow the vein and cell terminology of Miller (1969) and genitalic armatures terminology of Higgins (1941, 1955) with some changes, pointed out in the text.

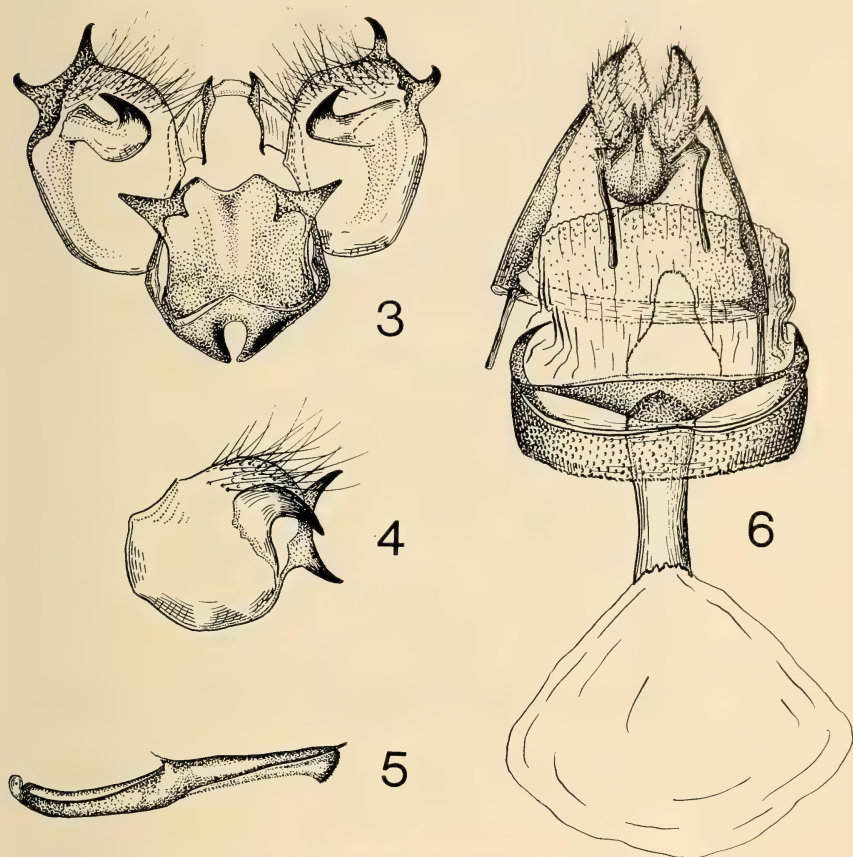
***Melitaea vedica* Nekrutenko, new species**

(Figs. 1, 2)

Male. Length of the forewing (base to tip) of the holotype 16.5 mm (variation in type series 15.0–17.5 mm). Upperside ground color of both wings orange-yellow, faded (fresh specimens). Fringe checkered, at vein tips black, between veins white; fringe of hindwing upperside white. Submarginal pattern of both wings consists of three black bands, joining along the veins. Spaces between these bands form two rows of ground color spots: marginal of crescent shape, and antemarginal of round shape. Antemarginal spots colored somewhat more vivid than ground color, those in cells M_3 – Cu_1 and Cu_1 – Cu_2 of forewing in most specimens examined are opened basally. Postdiscal pattern consists of a S-shaped row of bold black spots on the forewing, and 3–4 small diffused spots in cells M_2 – M_3 , M_3 – Cu_1 , Cu_1 – Cu_2 and Cu_2 –2A on hindwing. (In *M. turkmanica* Higgins and *M. collina* Lederer this row is complete.) Discal spot wide, closed, its interior orange-yellow, slightly more vivid than ground color; two spots of similar shape and color also in central and Cu_2 –2A cells of forewing. At costal edge of forewing, between antemarginal and postdiscal spots, lies an elongated, white to bright-yellow, mark. Veins on the



Figs. 1, 2. *Melitaea vedica* n. sp.: holotype, ♂, upper and undersides, Caucasus Minor, Armenia, Vedi District, Chosrov Wildlife Reservation, 1300–1500 m, 15 May 1974, Y. Nekrutenko.



Figs. 3-6. *Melitaea vedica* n. sp., paratypes, genitalia. Male genitalia: 3, ventral view, aedeagus removed; 4, valva, inner surface; 5, aedeagus, lateral view; 6, female genitalia.

hindwing upperside black, body fold richly powdered with black scales. Underside: forewing ground color bright yellow, with a notable pink shade. All black elements, except for postdiscal spots, slender. Ground color of marginal area rather whitish. Antemarginal spots in cells M_2 - M_3 , M_1 - M_2 and R_5 - M_1 centered with large diffused yellow pupils. Hindwing ground color chalky-white, consists of common to *phoebe*-group elements.

Male genitalia (Figs. 3-5): Ringwall short, pillow-shaped, bears two pairs of lingulae (nec sensu Higgins, 1941), lateral and internal. Saccus rhomboidal, with deep anterior incision. Valva (clasp of Higgins, 1941) (Fig. 4) rounded, bears two posterior processes of equal size; internal process (harpe of Higgins, 1941) strongly chitinated, short, horn-shaped. Aedeagus (penis of Higgins, 1941) (Fig. 5) straight, ends at apex, bears well developed oleocranon and ostium fold.

Female. Length of forewing of two female paratypes (base to tip) 17.0 mm. Wing pattern identical with that of male, but black elements developed somewhat



Fig. 7. *Melitaea vedica* n. sp., type locality. Thin forest of *Juniperus polycarpus* at an elevation of 1400 m, Chosrov Wildlife Reservation (Armenia).

stronger. The sexual dimorphism is so poorly expressed that there is no need to figure a female.

Female genitalia (Fig. 6): Papillae anales falcate. Length of apophyses posteriores equal to that of papillae, longer than apophyses anteriores. Genital plate funnel-shaped, auricles weakly developed. Scutum membranous, transparent, with notable cellular sclerotization, at anterior half bears a pear-shaped perforation. Ductus bursae (bacillus of Higgins) strongly chitinized, tubiform. Bursa copulatrix round ovate, slender, no signa or similar structures were observed.

Types. Holotype, male, Caucasus Minor, Armenian Soviet Socialist Republic, Vedi District, Chosrov State Wildlife Reservation, 1300–1500 m, 15 May 1974, Y. Nekrutenko. Paratypes, 23 ♂♂, 2 ♀♀, 15–30 May, same locality and collector.

Holotype, 4 ♂♂ and 1 ♀ paratypes will be deposited in the Zoological Institute, U.S.S.R. Academy of Sciences (Leningrad), 5 ♂♂ paratypes in the British Museum (Natural History), 5 ♂♂ paratypes in the Zoological Museum of the Kiev State University, and 1 ♂ paratype in the collection of E. S. Miljanowski (Sukhumi, Georgia). All other types are in the author's collection.

Type locality (Fig. 7). Chosrov Wildlife Reservation is situated on a south-eastern spur of the Gegam Mountain Range (Caucasus Minor), within the juniper thin forest (*Juniperus polycarpus* C. Koch.). *M. vedica* n. sp. flies over sunny hot spots, protected from winds, along ravines, montane road benches, and other de-

pressions; females prefer grassy spots. The new species flies together with *M. phoebe* Den. & Schiff., *M. cinxia* L., *M. transcaucasica* Trti (ssp.) and *M. arduinna* Esp. (ssp.).

The described species belongs to the small representatives of the *M. phoebe* group. The essential feature of these butterflies, apart from their size, is the presence of one inferior (*M. collina*), or two superior and inferior (*M. consulis* Wiltshire, *M. turkmanica*, *M. vedica* n. sp.) posterior processes of the valva. Large representatives of the group (*M. phoebe*, *M. scotosia* Butl., *M. aetheriae* Hübn. and *M. sibina* Alph.) are characteristic with a tridentate end of the valva. The superficial appearance of *M. vedica* n. sp. seems to be distinctive enough to recognize it at a glance, without confusion with the other "dwarfs" mentioned above.

ACKNOWLEDGMENTS

My sincere thanks are due to colleagues who generously helped me in the field work: Drs. Arnold M. Gegetshkori and Mark V. Stolyarov of Tbilisi. I thank Prof. Dr. Eugene M. Shumakov (Leningrad) and Dr. Eugene S. Miljanowski (Sukhumi) for exciting discussion. This paper was kindly corrected and edited by Dr. George L. Godfrey.

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MORE ON *URBANUS DORANTES* (HESPERIIDAE)

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Knudson (1974) has well summarized the current status of the recently introduced *Urbanus dorantes dorantes* Stoll in Florida. Briefly it is as follows: It was first taken in southern Florida in 1969 (Clench, 1970; Pliske, 1971). Since that time it has spread over most of the state, northward to Alachua and Nassau counties at least, and seems to be common almost everywhere. Particularly interesting is that this new arrival in Florida represents the mainland Middle American subspecies rather than *U. d. santiago* Lucas of Cuba, which would have been more understandable. That *d. dorantes* was introduced into Florida by human agency (Miller & Miller, 1970) seems the most reasonable explanation, but natural spread from Texas around the Gulf Coast cannot be ruled out.

I have now to report a further interesting record. In connection with work I am doing on the butterflies of the Bahama Islands, Mr. David Hall of Lichfield, England, was so kind as to send me recently a full list of the butterflies he took on Grand Bahama Island while he was resident there from 1968–1973. Even more generously, Mr. Hall also offered to send for examination any of his specimens that I might wish to see. On his list were two entries that are relevant here. One was "*Urbanus dorantes?*" and the other "*Urbanus* sp." I wrote and asked to see them both.

The "*Urbanus* sp." turned out to be a male of *U. dorantes dorantes*, taken at Freeport, Grand Bahama, 1 December 1971, in a hardwood hammock. The specimen is in good condition except that it has lost both tails. Mr. Hall noted in his accompanying letter that it was taken that way. This specimen, its pattern in all respects typical of nominate *dorantes*, without much doubt either crossed from Florida to Grand Bahama itself, or is descended from a female that did.

Urbanus dorantes santiago, the Cuban subspecies, also occurs in the Bahamas. Hitherto it has been known only from Andros Island (Rindge, 1952; Mangrove Cay, July, Mus. Comp. Zool.; Nicolls Town, North Andros, various dates in June 1973 and November 1973, *leg.* H. Clench, Carn. Mus.; Driggs Hill, South Andros, various dates in June 1974, *leg.* H. Clench, Carn. Mus.), where it is common.

Mr. Hall and I, however, have both found *santiago* on Grand Bahama as well, where it seems to be rare. Mr. Hall has taken two specimens

(Seagrape, 24 October 1971; Eight Mile Rock, 19 May 1973) and I have taken only one (Pine Ridge, 4 mi. NE Freeport, 12 June 1974). Both the Seagrape specimen (the "*Urbanus dorantes*?" above, which I have examined) and my own agree well with long series from Andros and Cuba.

The interesting situation thus exists of two different (and quite different looking) subspecies of *Urbanus dorantes* both having been taken on Grand Bahama. We are left with several questions, which only time and further collecting on the island may answer.

Was the capture of nominate *dorantes* there only a fluke? If not, will it hybridize with resident *santiago*? (My 1974 specimen shows no evidence of it; it is, if anything, in extreme contrast to *d. dorantes*.) If the two do hybridize, as our present taxonomic evaluation of them suggests they should, then will we see a hybrid mixture of traits, or a swamping of one by the other? Whatever may happen the situation merits future attention.

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SOCIEDAD MEXICANA DE LEPIDOPTEROLOGÍA

Sociedad Mexicana de Lepidopterología was created in December 1974 to foment the study of the diverse aspects of butterflies and moths. It is open to all persons interested in any aspect of butterflies and moths, especially of Mexico. The first number of its Journal will be published in 1975. The officers of this new society are *President*, Dr. Carlos R. Beutelspacher, Instituto de Biología, Apdo. Postal 70-153, México 20, D. F.; *Secretary*, Sr. Roberto de la Maza, Jr., Nicolás San Juan 1707, México 12, D. F.; and *Treasurer*, Sr. Alberto Díaz Francés, Berlín 105, Col. Coyoacán, México 21, D. F. Prospective members may write to any of these gentlemen for additional information.

ED. NOTE: On behalf of The Lepidopterists' Society, I congratulate the founders of the Sociedad Mexicana de Lepidopterología for their accomplishment, and wish this new society and its officers much success in furthering the knowledge of the interesting lepidopterous fauna of Mexico.

THE NEOTROPICAL METALMARK *HERMATHENA OWENI*
(RIODINIDAE): NEW RECORDS AND MAJOR EXTENSION
OF THE KNOWN RANGE FROM COSTA RICA TO
EL SALVADOR AND MEXICO

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In the montane pine and oak forests south of San Cristobal de las Casas, Chiapas, Mexico, a number of unusual butterflies were taken by one of us (T. C. E.) during March 1959. The first record of *Colias philodice* Godart (Pieridae) for Mexico was previously reported (Emmel, 1963) from these high (7,600 ft. elevation), predominantly coniferous forests. Other, more typically Central American species were taken that spring in this location, e.g., *Anelia* (= *Clothilda*) *euryale* Doubleday & Hewitson and *Anaea excellens* Bates (both Nymphalidae). Along with these was an extraordinary large white metalmark which was previously known only from the type specimen collected in Costa Rica.

This striking riodinid, *Hermathena oweni*, was described and figured in color by Schaus (1913; 350; pl. LIII, fig. 9) from a single male collected in Costa Rica, with no further locality, by Professor Owen of the University of Wisconsin. Since there are no native pines in Costa Rica, this specimen was probably collected in the oak forests which do occur at high elevations (7,000–10,000 ft.) in that country. The original description accurately matches the Chiapas male collected in 1959 (Figs. 1 & 2) (maximum wing expanse 38 mm, forewing length 21 mm). Because of the rarity of the original paper and the unusual pierid-like pattern of the butterfly, Schaus' description of his male is quoted here:

Head and thorax black clothed with greyish-white hairs. Abdomen grey, with transverse black segmental shades. Wings white, the base mottled with black with traces of a subbasal whitish line; spots black, two beyond cell; a medial spot below vein 2; subterminal quadrate spots above and below vein 6, also above and below vein 3; apex black; spots at ends of veins; terminal interspaces between veins 2 and 3, and 4 and 6 mottled with black. Hind wings: terminal spots at veins; subterminal quadrate spots above and below vein 7. Underneath similar; the basal mottling showing through from above; the terminal markings on interspaces entirely black. Expanse 42 mm.

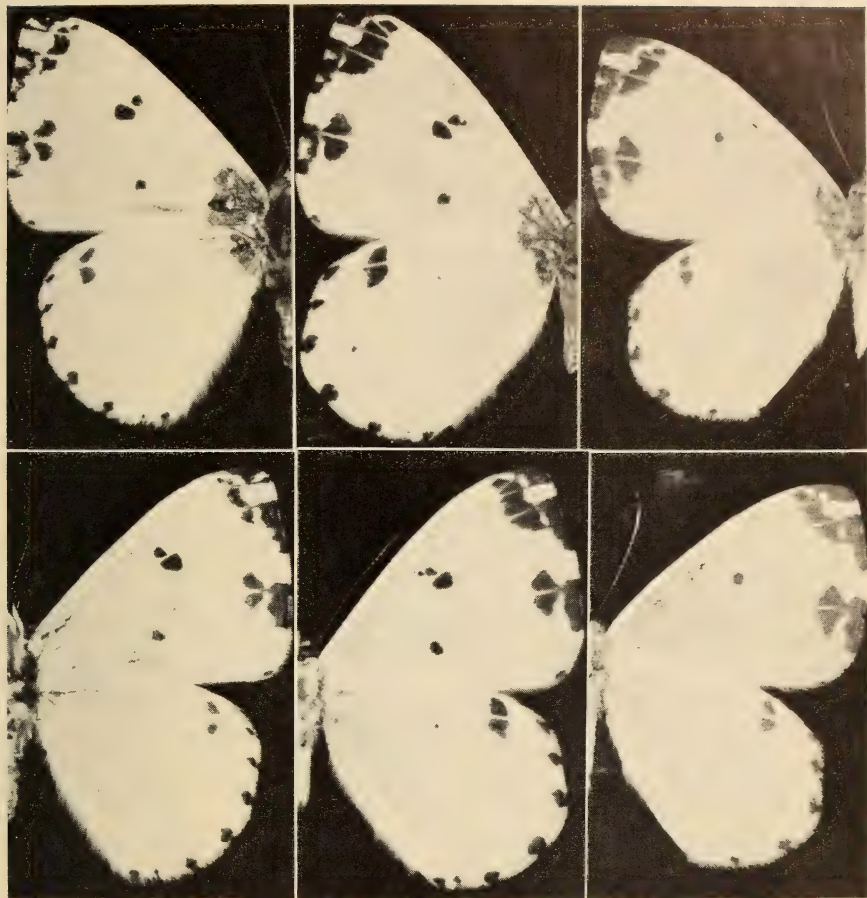


Fig. 1. Adults of *Hermathena oweni* Schaus: upper surfaces (top) and under surfaces (bottom). Left: ♂, Mexico, Chiapas: 12 km S San Cristobal de las Casas, March (T. C. Emmel); forewing length 21 mm. Center: ♀, Mexico, Chiapas: Ochuc, July (R. G. Wind); forewing length 23 mm. Right: ♀ (form "*dativa*" Schaus), Mexico: Chiapas: Santa Rosa Comitán, May (T. Escalante); forewing length 18 mm.

Seitz (1916) placed *oweni* as a subspecies of *H. candidata* Hewitson, but the figure given of the subspecies *columba* Stichel (Seitz, 1916: pl. 126d) suggests that *oweni* is a distinct and totally different species. One of us (L. D. M.) has compared *oweni* and *candidata* superficially and is of the opinion that they are not conspecific.

Since the 1959 specimen collected by Emmel, additional specimens have been taken in Mexico and El Salvador. These specimens are now



Fig. 2. Male genitalia of *Hermathena oweni* Schaus, same ♂ as in Fig. 1 (slide M-1790; Lee D. Miller).

in the collection of the Allyn Museum of Entomology and are from the following localities:

MEXICO: CHIAPAS: Santa Rosa Comitán, iv–vii, ix, 4 ♂, 3 ♀ (all T. Escalante); Ochuc, vii–viii, 1 ♂, 1 ♀ (both R. G. Wind); Campet, xi, 1 ♀ (R. G. Wind); cloud forest above Lago Tiscon, Lagos de Montebello, ix, 1 ♀ (R. G. Wind). VERACRUZ: Dos Amates, ix, 1 ♂ (T. Escalante). EL SALVADOR: METAPAN: Cerro Miramundo cloud forest, iv–v, 1 ♂, 1 ♀ (S. L. and L. M. Steinhauser and E. Manley).

In addition, Robert Wind (*pers. comm.*) has informed L. D. M. that he has two other specimens from Ochuc, Chiapas, thus raising the number of known Mexican specimens to at least 15.

About this insect in El Salvador, S. L. Steinhauser has written to one of us (L. D. M.):

At Miramundo in the cloud forest we have seen them fairly commonly from late February to June flying high in the canopy where they look like pierids. They will rest beneath leaves with wings flat, but they also perch at times on the upper surfaces of leaves with wings erect (territorial defense?). Frequently they are observed in groups of three or four flying peacefully together. They almost never come lower than 20 feet above the ground and usually fly at 50–75 feet above ground level, depending on canopy height.

Steinhauser also mentions at least one other specimen taken at Cerro Miramundo (elev. 2300–2400 m = 7,600–8,000 ft.) in the cloud forest.

Much of the material from Santa Rosa Comitán, Chiapas, as well as that specifically from the Lago Tiscon area, is from cloud forests, and this vegetational formation may be the favored home of *oweni*. If so, the type specimen from Costa Rica probably came from one of the patches of cloud forest scattered throughout the basically oak woodlands of the Sierra de Talamanca alluded to earlier in this report.

The Steinhauser observation suggests that *H. oweni* is not nearly so rare as has been previously assumed, but since it flies in relatively inaccessible areas, at relatively inaccessible heights, it is seldom collected.

Schaus (1928: 47-48) later described *H. dativa* from a single female taken on Volcan Santa Maria, Guatemala, at 7,000 ft. This name applies to specimens that are similar to typical *oweni*, but lack the forewing median dark spots, except for the one in M_2-M_3 outside the cell. The terminal spots and basal shading are as in *oweni*, but perhaps less well developed. Two females in the Chiapas series of *oweni* in the Allyn Museum material show these traits, but are not otherwise separable from typical *oweni*. An additional specimen or two in the series also show transitional configurations of the median spots, and it is evident that *dativa* (Fig. 1) represents no more than an extreme form of *oweni* and should be placed in the synonymy of the latter [NEW SYNONYMY].

ACKNOWLEDGMENTS

We would like to thank Mr. Stephen L. Steinhauser for his observations on the habits of this insect. We are also grateful to Dr. J. F. Gates Clarke and Mr. William D. Field for access to the type-specimens of both species in the collections of the National Museum of Natural History, Washington, D.C. Our thanks go also to Mr. A. C. Allyn for the photography of the specimens and to Mrs. Jacqueline Y. Miller for the drawing of the male genitalia.

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LARVAL FOODPLANT RECORDS FOR 106 SPECIES OF
NORTH AMERICAN MOTHS

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Since I donated the remainder of my former North American insect collection to the Natural History Museum of Los Angeles County, California (Donahue, 1972), it now seems worthwhile to report many of the larval foodplant records associated with the moth life history material. These specimens (both immatures and associated adults) comprise about 40% of the total collection, and are now available for loan to specialists. The majority of species represented are from localities in California and Oregon; a few are from Arizona, central New Mexico and eastern Kansas. Foodplant records for some of these moths have already been published (Buckett, 1964, 1970; Hogue et al., 1965; McFarland, 1959-1967); only a few of these have been repeated again here, but with corrected or *additional* data in all cases. Many of the foodplant names appearing here are entirely new records, or at least have never been published for the localities concerned, even though some of them may be known to certain workers. Probably fitting the latter category are some Oregon records which appeared in my Master's thesis (1963), of which 20 copies were privately distributed in 1963-64. These records still remain to be made "official" through publication, however, so are included in the present paper.

I was inspired to compile this list after reading a recent plea by R. B. Dominick (1972) and an excellent paper by Shields, et al. (1970). I have essentially followed the format devised by the latter *for reporting larval foodplants*, as illustrated under the 14 butterfly species included in their paper. One small change to their basic format has been made to emphasize a certain point: This is the capitalization of all plant family names. The plant *families* involved in foodplant records are all too often omitted in publications (McFarland, 1970). Other small changes or additions have also been made to enhance the readability of this list, and sometimes to increase the amount of information conveyed. For example, the months or seasons of peak *larval* occurrence are included for the localities named, where known with certainty.

Many of the records given here are documented by extensive notes—also in possession of the Los Angeles County Museum of Natural History; these are tied, by code-numbers, to associated pinned adults having blue labels and to their associated immatures, which have been fixed in

K.A.A.D. or K.A.S.A. and preserved in 95% ethyl alcohol. Occasional empty cocoons (on pins) were kept for the dry collection.¹

All foodplant determinations have been carefully checked in various floras, as were available for the localities concerned during the period when I was doing this work. Those for western Oregon were kindly verified by Dr. K. L. Chambers of the Botany Department at Oregon State University, Corvallis. Other plant determinations are by the author (unless otherwise stated), following Munz & Keck (1959) or Thompson & Raven (1966) for California and Stevens (1948) for Kansas. An asterisk (*) before the plant indicates a species not native to the locality named.

My interpretation of plant families, subfamilies and tribes mostly follows the recent world synopsis of the higher classification of the flowering plants by Thorne (1968). This involves a few shifts of familiar names. For example, Asclepidaceae is treated by Thorne as a subfamily (-oideae) of APOCYNACEAE; Apiaceae (Umbelliferae) becomes a subfamily under ARALIACEAE. Only the standard ending (-aceae) is used for all plant families (for reasons, see McFarland, 1970). This only involves changes for eight well-known names having irregular endings, as follows: Compositae becomes ASTERACEAE; Cruciferae = BRAS-SICACEAE; Gramineae = POACEAE; Guttiferae = CLUSIACEAE; Labiatae = LAMIACEAE; Leguminosae, s.l. = FABACEAE; Palmae = ARECACEAE; Umbelliferae = ARALIACEAE, subfam. Apioideae.

Any foodplant record which begins with the phrase "Captive larvae readily (or avidly) accepted" implies that those larvae were reared from eggs (ex confined females) and were in captivity right from the start; the foodplant named was the one most readily accepted by them, from whatever selection of plants they were offered at the time of the rearing. Such records should not be interpreted as implying *chosen* foodplants under natural conditions; continuing fieldwork will eventually clarify these records. However, if the larvae did not thrive upon a plant and *successfully produce normal adults*, the plant was not listed in this paper. Foodplant records preceded simply by the word "on" (or "defoliating")

¹ Pinned cocoons and many soil-cells are well worth saving as useful comparative material in any life history collection. Also worth saving are dried samples of last instar frass pellets, and sometimes examples of the larval nests or of typical feeding-damage to the foodplant, in those (occasional) instances where these show distinctive features. An example of the latter would be pressed mature leaf specimens of *Rhus laurina*, showing the peculiar typical feeding-pattern of the noctuid, *Paectes declinata* Grt. on that plant (McFarland, 1965). Frass pellets are not always worth preserving, but sometimes they are unique in morphology and some are even readily identifiable in the field, once known to the observer. There are three major requirements for the successful long-term preservation of larval frass, of which the first-listed is most vital: (1) thorough drying; (2) enclosure thereafter in a small and air-tight glass vial; (3) firm cushioning inside the vial, between two small wads of cotton, to prevent any subsequent crumbling due to vibration or container movement during handling. Alternatively, dry frass samples can be glued in rows, on small cards, and then pinned in the dry collection. In a glued series, some pellets should be arranged to show the ends as well as the sides.

imply field-collected larvae, found feeding ON the plant(s) named, under natural conditions. It is most important that all writers make clear these distinctions ("accepted" vs. "on") when reporting larval foodplants.

The larvae may be assumed leaf-feeders if the part of the foodplant eaten (or preferred) is not specifically mentioned. As the distinction between *young* (new) leaves and *mature* (old) leaves is often of great importance, particularly in connection with sclerophyllous plants, this has always been reported whenever such preferences could be discerned from the larval feeding habits. (See also McFarland, 1965).

There are three major localities constantly repeated in the list that follows. Rather than writing them out completely each time they recur, they are recorded in full only once, below:

- (1) * SW. CALIF. (A): California, Los Angeles County, eastern Santa Monica Mountains (1100' elev.), \pm 5 mi. N of Beverly Hills, at (or near) 9601 Oak Pass Road, in a Coastal Sage Scrub + Chaparral + Southern Oak Woodland mixed association (after Munz & Keck, 1959). This habitat has been described as it was in its undisturbed state (prior to "development"); see McFarland (1965); McFarland & Colburn (1968).
- (2) * SW. CALIF. (B): Los Angeles County, northern slope of the San Gabriel Mountains (4800'-5000' elev.), near the western edge of the Mojave Desert, 2.5 mi. SSW of Valyermo, at (or near) White Cliff Ranch, in an arid Chaparral and Pinyon Woodland ecotonal association (after Munz & Keck, 1959). This habitat has been briefly described by Robertson (1970), including a list of some of the dominant flowering plant genera and species occurring there.
- (3) * W. OREGON: Benton County, in the Coastal Ranges, at McDonald Forest Reserve (\pm 500' elev.), Oak Creek Fisheries Lab, 5 mi. NW of Corvallis, in a mixed coniferous and deciduous forest association. This habitat has been described by McFarland (1963).

These three localities are referred to in the list simply as "* SW. CALIF. (A)," "* SW. CALIF. (B)" and "* W. OREGON."

Localities named are always the exact source-localities of the specimens (either of the original adult females from which eggs were obtained, or of the field-collected larvae), regardless of whether or not the resulting eggs or larvae were later transported to some other locality during the period of rearing. If I have differing foodplant records for the same moth species, from more than one locality, the localities are numbered consecutively (as under the arctiid, *Hemihyalea edwardsii*). Any *months* (or seasons) given in parentheses imply the time of year when partially-grown to mature larvae are most likely to be found in those localities on the plants listed.

Conditions in some of my former collecting localities are now so drastically changed, due to the destructive activities of *Homo sapiens* (so-called "development," etc.), that it now seems important to record the *years* of these observations in addition to the months. Therefore,

the years are usually given in parentheses at or near the end of each entry; these indicate the *first* year of that foodplant record by the author. In some localities there were repeated observations involving more than one year.

For reasons discussed earlier (McFarland, 1970) the moth list is arranged alphabetically by family, genus, and species. My former larval collection code-numbers appear, wherever applicable, after the initials of the determining authorities. *Only* species so code-numbered are represented by preserved (alcoholic) immatures and/or notes in the Los Angeles County Museum of Natural History.

The following *abbreviations* are used throughout the list: lf. = leaf; lvs. = leaves; fl. = flower; fls. = flowers; nr. = near; \pm means approximately.

ARCTIIDAE

Apantesis nevadensis (G. & R.) (det. LM)—Ar.27. NEW MEXICO, NE of Albuquerque, W base of the Sandia Mts., La Cueva Recreation Area (\pm 5200'): Nearly fullgrown larvae (May) on lvs. of Great Basin sagebrush, *Artemisia tridentata* Nutt.—ASTERACEAE (1958).

Apantesis nevadensis geneura (Stkr.) (det. LM)—Ar.28. CALIF., Los Angeles Co., Mint Canyon (SW of Palmdale): Larvae (April) on lvs. of fiddleneck, *Amsinckia ?intermedia* F. & M. (corolla deep yellow)—BORAGINACEAE, growing as ephemeral herbaceous cover among junipers (*Juniperus californica* Carr), along side of road (1956).

Arachnis picta picta Pack. (det. LM, NM)—Ar.20. *SW. CALIF.(A): Older larvae (April–May) on lvs. of deerweed, *Lotus scoparius* (Nutt. in T. & G.) Ottley—FABACEAE (apparently a “preferred” foodplant in this locality); also often on mustards, such as **Brassica geniculata* (Desf.) J. Ball—BRASSICACEAE and cheese-weed, **Malva parviflora* L.—MALVACEAE (1950–57).

Arctia caja waroi B. & B. (det. JD)—Ar.17. *W. OREGON: Older larvae (May) commonly feeding on mature, tough lvs. of bracken, *Pteridium aquilinum* (L.) Kuhn—POLYPODIACEAE. Although these larvae are more-or-less polyphagous on low-growing plants, an apparent preference for bracken is evident in this locality, at least during later instars (1962).

Clemensia albata Pack. (det. BB)—Ar.33. *W. OREGON: Captive larvae (autumn–spring) readily accepted the locally-common foliose lichen, *Lobaria pulmonaria* (L.) Hoffm.—STICTACEAE (1962).

Euchaetias egle (Dru.) (det. NM)—Ar.7. KANSAS, Douglas Co., Lawrence (in a city garden): Larvae (Sept.) on *Gonolobus laevis* Michx.—APOCYNACEAE (1960).

Haploa lecontei (Bdv.) (det. JD)—Ar.1. KANSAS, Douglas Co., 7 mi. NE of Lawrence, Univ. of Kansas Natural History Reservation: Larvae (May) on *Ceanothus ovatus* Desf.—RHAMNACEAE and *Symphoricarpos orbiculatus* Moench—CAPRI-FOLIACEAE. An apparent preference for these two plants is evident on the prairie tract of the Reservation, even though these larvae are probably more-or-less polyphagous (1960).

Hemihyalea edwardsii (Pack.) (det. LM)—Ar.3. (1) *SW. CALIF.(B): Larvae (summer) feeding at night on tough-sclerophyll mature lvs. of *Quercus chrysolepis* Liebm.—FAGACEAE (1960). (2) *W. OREGON: Captive larvae readily accepted mature lvs. of *Q. garryana* Dougl. (1962).

Kodiosoma fulva Stretch (det. JD)—Ar.29. CALIF., Los Angeles Co., \pm 2 mi. WSW of Valyermo, in dry river beds (Cruthers and Pallett Creeks), among large rocks (\pm 4000' elev.): Larvae (March–April) on *Stephanomeria pauciflora* (Torr.) Nutt.—ASTERACEAE (det. CH). I am indebted to Mr. C. Henne, of Pearblossom, Calif., for originally showing me these larvae (1963).

Leptartia californiae (Walk.) (det. LM)—Ar.18. (1) ARIZONA, Coconino Co., Williams, along roadside (\pm 6700' elev.): Nearly fullgrown larvae (Aug.) abundant (feeding at night) on lvs. of white sweet clover, **Melilotus albus* Desr.—FABACEAE (1955). (2) OREGON, Jackson Co., nr. Dead Indian Soda Springs: Larvae (June), obtained from eggs in captivity, readily accepted mature lvs. of bracken, *Pteridium aquilinum* (L.) Kuhn—POLYPODIACEAE; the larvae showed a distinct preference for this plant over all weeds and other plants offered to them in captivity, although they are probably \pm general feeders under natural conditions (1962). For an interesting and detailed study of a western Oregon population of this species, see Mays (1966).

Maenas vestalis (Pack). (det. NM)—Ar.21. (1) *SW. CALIF.(A): Eggs and early instar larvae (March–April) almost invariably on mature lvs. of wild cucumber or man-root, *Marah macrocarpus* (Greene) Greene—CUCURBITACEAE, in this locality; later dispersing to other plants, because the soft and rank-growing *Marah* shrivels and dies early in the summer long before these larvae reach full growth. They wander widely, feeding (well into the summer) on many unrelated plants after leaving the *Marah*. Captive larvae readily accepted mature lvs. of Calif. black walnut, *Juglans californica* Wats.—JUGLANDACEAE, and completed growth on this plant alone, in excellent condition (1952). (2) CALIF., Los Angeles Co., San Gabriel Canyon, Camp Coldbrook: Small Larvae (May) on *Tauschia arguta* (T. & G.) Macbr.—ARALIACEAE; these larvae were kindly provided by John F. Emmel (1962).

Platyrepia guttata (Bdv.) (det. NM)—Ar.16. *W. OREGON: Larvae (April) \pm polyphagous on luxuriant low-growing herbs, but later instars show an obvious preference for the basal lvs. of a locally-common large thistle, *Cirsium* sp.—ASTERACEAE, usually growing in open-sunny, low, damp areas in this locality (1962).

Spilosoma vagans (Bdv.) (det. JD)—Ar.15. CALIF., Mendocino Co., Hwy. 1 at Ten Mile River, N of Fort Bragg: Larvae (Sept.) sheltering under a low-growing perennial *Lupinus* sp.—FABACEAE, by day; feeding on the lvs. of this plant after dark; in a coastal sand dune habitat (1961).

CTENUCHIDAE (AMATIDAE)

Ctenucha brunnea Stretch (det. LM)—Am.3. *SW. CALIF.(A): Larvae (April–May) were often common in clumps of giant ryegrass, *Elymus condensatus* Presl.—POACEAE (1948). The numbers of adults of this sp. seem to have diminished tremendously in this locality since the late 1940's–early 1950's, although the foodplant was still common here into the early 1970's. (For additional details, see also McFarland, 1965: 54.)

Ctenucha rubroscapus (Men.) (det. BB)—Am.2. *W. OREGON: Captive larvae (June) readily accepted mature lvs. of orchard grass, **Dactylis glomerata* L.—POACEAE (1962).

DREPANIDAE

Drepana arcuata Walk. (det. NM)—Dr.1. *W. OREGON: Larvae (autumn) on mature lvs. of red alder, *Alnus oregona* Nutt. (syn. = *A. rubra* Bong.)—BETULACEAE (1961).

Drepana bilineata Pack. (det. BB)—Dr.2. *W. OREGON: Captive larvae

(spring) readily accepted lvs. of **Betula* sp. (ornamental weeping birch)—BETULACEAE, but positively refused the local (native) *Alnus oregona* Nutt. of the same family (1962). Oak (*Quercus garryana*) might be the native foodplant in this locality.

GEOMETRIDAE

Anavitrinella pampinaria Gn. (det. BB)—G.24. *W. OREGON: Larvae (autumn) on *Alnus oregona* Nutt.—BETULACEAE (1961).

Biston (*Amphidasis*) *cognataria fortitaria* B. & McD. (det. CK)—G.25. *W. OREGON: Larvae (autumn) on *Alnus oregona* Nutt.—BETULACEAE (1961).

Campaea perlata Gn. (det. BB)—G.37. *W. OREGON: Captive larvae (June) readily accepted *Alnus oregona* Nutt.—BETULACEAE (1962).

Caripeta aequaliaria Grt. (det. BB)—G.39. *W. OREGON: Captive larvae (Aug.) avidly accepted mature lvs. of Douglas fir, *Pseudotsuga menziesii* (Mirb.) Franco.—PINACEAE (1962).

Chlorochlamys appellaria Pears. (det. NM)—Gm.20. *SW. CALIF.(B): Larvae (summer) on fl. heads of wild buckwheat, *Eriogonum fasciculatum* ssp. *polifolium* (Benth.) S. Stokes—POLYGONACEAE (1961).

Chlorosea banksaria gracearia Sperry (det. CK)—Gm.70. *SW. CALIF.(B): Captive larvae (summer) readily accepted birchleaf mahogany, *Cercocarpus betuloides* Nutt. ex T. & G.—ROSACEAE (1964).

Cingilia (*Nepytia*) *phantasmaria* Stkr. (det. CK)—G.49. *W. OREGON: Captive larvae (summer) readily accepted young lvs. (only) of *Pseudotsuga menziesii* (Mirb.) Franco.—PINACEAE (1962).

Cingilia umbrosaria nigrovenaria Pack. (det. CK)—G.40. *W. OREGON: Captive larvae (Oct.–Nov.) readily accepted Douglas fir, *Pseudotsuga menziesii* (Mirb.) Franco.—PINACEAE (1962).

Cochisea sinuaria B. & McD. (det. LM)—G.53. (1) *SW. CALIF.(A): Larvae (spring) on mature lvs. of laurel-leaf sumac, *Rhus laurina* Nutt. in T. & G.—ANACARDIACEAE (1956). (2) *SW. CALIF.(B): Larvae (spring) on young lvs. of *Arctostaphylos glauca* Lindl.—ERICACEAE; captive larvae readily accepted *Cercocarpus betuloides* Nutt. ex T. & G.—ROSACEAE (1963).

Cosymbia dataria piazzaria Wgt. (det. CK). *SW. CALIF.(A): Larvae (July–Aug.) abundant on fls. and buds of a tarweed, *Hemizonia ramosissima* Benth.—ASTERACEAE (1948 +).

Deuteronomos magnarius ochreateus Hlst. (det. CK)—G.32. *W. OREGON: Larvae (autumn) on mature lvs. of *Alnus oregona* Nutt.—BETULACEAE (1961).

Dichorda illustraria (Hlst.) (det. LM)—Gm.22. *SW. CALIF.(B): Captive larvae (Aug.) avidly accepted mature lvs. of squawbush, *Rhus trilobata* var. *anisophylla* (Greene) Jeps.—ANACARDIACEAE (1961).

Dysstroma citrata L. (det. CK)—G.28. *W. OREGON: Captive larvae (early spring) avidly accepted young lvs. of *Geum macrophyllum* Willd.—ROSACEAE (1962).

Earophila pectinata Rindge (det. FR)—G.58. CALIF., Los Angeles Co., 4–5 mi. S of Pearblossom, near N base of San Gabriel Mts. (\pm 4000'–4200'): Larvae (May) on lvs. of the viscid, woody shrub, *Purshia glandulosa* Curran—ROSACEAE. Obtained by beating; fairly common (1964). Chris Henne kindly completed this rearing for me, from pupa to adult.

Earophila vasiliata Gn. (det. CK)—G.46. *W. OREGON: Captive larvae (spring) readily accepted young lvs. of wild blackberry, *Rubus* sp.—ROSACEAE (1963).

Enypia griseata Grossb. (det. CK)—G.41. *W. OREGON: Captive larvae (summer-autumn) readily accepted *Pseudotsuga menziesii* (Mirb.) Franco.—PINACEAE (1962).

Epirrhoe plebeculata Gn. (det. CK)—G.30. *W. OREGON: Captive larvae

(April) avidly accepted youngest lvs. and tips (only) of bedstraw, *Galium* sp.—RUBIACEAE (1962).

Eupithecia nevadata Pack. (det. FR)—G.34. CALIF., Los Angeles Co., San Gabriel Canyon, Camp Coldbrook: Larvae (May) on *Lotus scoparius* (Nutt. in T. & G.) Ottley—FABACEAE (det. J. F. Emmel). These larvae were kindly provided by John F. Emmel (1962).

Fernaldella fimetaria G. & R. (det. CK)—G.3. CALIF., San Bernardino Co., Mojave Desert, Apple Valley, at junction of Ramona and Navajo Roads, in a Joshua-creosote association ($\pm 3000'$): Larvae (June) fairly common on a matchweed, *Gutierrezia microcephala* (DC.) Gray—ASTERACEAE (1960). Feeding at night.

Itame extemporata B. & McD. (det. CK)—G.66. *SW. CALIF.(B): Larvae (May) common on *Cercocarpus betuloides* Nutt.—ROSACEAE (1964). They are exceptionally superb mimics of the smaller gray twiglets of this shrub. Easily obtained by beating.

Itame guenearia Pack. (det. LM). *SW. CALIF.(A): Larvae (spring) on young lvs. of redberry, *Rhamnus ilicifolia* Kell.—RHAMNACEAE (1955).

Lambdina ?fisellaria somnaria Hlst. (det. CK)—G.35. OREGON, Polk Co., 5-7 mi. W of Monmouth: Larvae (autumn) defoliating *Quercus garryana* Dougl.—FAGACEAE (1961).

Merochlora graefiaria (Hlst.) (det. NM)—Gm.21. CALIF., San Bernardino Co., San Bernardino Mts., 1 mi. NE of Union Flat ($\pm 7500'$ elev.): Captive larvae (July-Aug.) accepted young lvs., buds, and fls. of Great Basin sagebrush, *Artemisia tridentata* Nutt.—ASTERACEAE. This plant was a dominant in the habitat (1961).

Nemoria ?intensaria (Pearsall) (det. NM)—Gm.74. CALIF., Los Angeles Co., 3 to 5 mi. S of Pearblossom, in a Joshua-juniper association ($\pm 3800'$ - $4000'$ elev.): Larvae (Sept.) on fls. of *Eriogonum plumatella* Dur. & Hilg.—POLYGONACEAE (1964).

Nemoria pulcherrima (B. & McD.) (det. BB)—Gm.45. *W. OREGON: Captive larvae (spring) avidly accepted catkins, tender young lvs., and lf. buds of *Quercus garryana* Dougl.—FAGACEAE (1963). Brown adult form common here (Feb.-March).

Philedia punctomaculata Hlst. (det. CK)—G.43. *W. OREGON: Captive larvae (May) avidly accepted young lvs. of bracken, *Pteridium aquilinum* (L.) Kuhn—POLYPODIACEAE (1962).

Plagodis ?phlogosaria approximaria Dyar (det. CK)—G.33. *W. OREGON: Larvae (May) on *Alnus oregona* Nutt.—BETULACEAE (1962).

Sabulodes caberata Gn. (det. NM)—G.23. (1) CALIF., Los Angeles Co., La Cañada, in a suburban garden: Larvae (spring) feeding readily on lvs. of English ivy, **Hedera helix* L.—ARALIACEAE (1952). (2) *W. OREGON: Larvae (autumn) on *Alnus oregona* Nutt.—BETULACEAE (1961).

Selenia alciphearia Walk. (det. CK)—G.29. *W. OREGON: Larvae (spring) on *Alnus oregona* Nutt.—BETULACEAE (1962).

Semiothisa colorata Grt. (det. FR)—G.59. CALIF., Los Angeles Co., ± 2 mi. S of Pearblossom, along Avenue X-8, in Creosote Brush Scrub ($\pm 3500'$ elev.): Larvae (May) abundant on creosote bush, *Larrea divaricata* Cav.—ZYGOPHYLLACEAE. Obtained by beating (1964).

Sicya pergilaria B. & McD. (det. FR)—G.18. *SW. CALIF.(B): Captive larvae (July) avidly accepted mistletoe, *Phoradendron flavescens* var. *villosum* (Nutt.) Engelm. in Rothr.—LORANTHACEAE, growing on its host, canyon oak, *Quercus chrysolepis* Liebm.—Fagaceae (1961).

Stannodes marinata Wright (det. FR)—G.31. SW. OREGON, Josephine Co., 4 mi. N of Galice (in a park): Larvae (May) abundant on young lvs. of *Cercocarpus betuloides* Nutt. ex T. & G.—ROSACEAE. These larvae were kindly provided by David R. Smith; obtained by beating (1962).

Synchlora liquoraria Gn. (det. CK)—Gm.19. *SW. CALIF.(B): Larvae (summer) on fl. heads of *Eriogonum fasciculatum* ssp. *polifolium* (Benth.) S. Stokes.—POLYGONACEAE (1961).

Triphosa californiata Pack. (det. CK)—G.52. *SW. CALIF.(B): Larvae (June) in silk-closed leaf-shelter nests, among young lvs. of redberry, *Rhamnus crocea* Nutt. ex T. & G. (ssp. ?)—RHAMNACEAE (1963).

Zophyta (Metasiopsis) perirrorata Pack. (det. CK)—G.6. CALIF., San Bernardino Co., Mojave Desert, Apple Valley, at junction of Ramona and Navajo Roads, in a Joshua-creosote association ($\pm 3000'$): Captive larvae (summer) avidly accepted a small annual spurge, *Euphorbia albomarginata* T. & G.—EUPHORBIACEAE (1960); they closely resembled the stems of this plant.

LASIOCAMPIDAE

Dicogaster coronada (Barnes) (?) (det. LM)—La.11. ARIZONA, Cochise Co., Chiricahua Mts., at the Southwestern Research Station ($\pm 5000'$): Captive larvae (summer-autumn) readily accepted mature lvs. of *Quercus chrysolepis* Liebm.—FAGACEAE, in the San Gabriel Mts. of S. Calif.; the indication was that they would be feeders upon *Quercus* in S. Arizona, as they avidly devoured the substitute species provided in S. California (1963).

Gloveria medusa (Stkr.) (det. LM). *SW. CALIF.(A): Larvae (spring) occurring and feeding on BOTH of the following in this locality: *Eriogonum fasciculatum* Benth.—POLYGONACEAE and *Quercus agrifolia* Nee—FAGACEAE. The former appears to be the "preferred" foodplant here. (See also McFarland, 1965).

Malacosoma californicum fragile (Stretch) (det. JD)—La.13. CALIF., Los Angeles Co., nr. Valyermo ($\pm 3500'$): Larvae (March–April) in conspicuous "tents" on *Prunus fasciculata* Gray—ROSACEAE (1964).

Tolyte sp., nr. *dayi* Blackmore (det. JD)—La.10. *W. OREGON: Captive larvae (summer), readily accepted Douglas fir, *Pseudotsuga menziesii* (Mirb.) Franco.—PINACEAE (1963).

Tolyte sp., nr. *distincta* French (det. JD)—La.5. *SW. CALIF.(B): Captive larvae (May–June) readily accepted young and semi-mature lvs. of *Quercus chrysolepis* Liebm.—FAGACEAE (1962). (See Buckett, 1964.)

Tolyte sp., nr. *glenwoodii* Barnes, or *austella* Franclemont (det. JD). *SW. CALIF.(A): Captive larvae (spring) readily accepted young lvs. of (only) *Ceanothus megacarpus* Nutt.—RHAMNACEAE, after 6–7 months of diapause in the egg stage. It is worth noting that larvae of this *Tolyte* were also offered lvs. of numerous other local woody plants, including *C. spinosus* Nutt. in T. & G., which they absolutely refused; the latter was the only other *Ceanothus* occurring in the locality named (1956). This moth was incorrectly listed under "*T. ?lowriei* B. & McD." by McFarland, 1965 (p. 60).

NOCTUIDAE

Admetovis oxymorus Grt. (det. LM)—N.31. CALIF., Ventura Co., Mt. Pinos, near summit (8800' elev.): Captive larvae (summer) readily accepted elderberry, *Sambucus mexicana* Presl.—CAPRIFOLIACEAE (1961).

Autographa biloba Steph. (det. LM). *SW. CALIF.(A): Larva (spring) on *Collinsia heterophylla* Buist. ex Grah.—LAMIACEAE (1954).

Behrensia conchiformis Grt. (det. J. S. Buckett)—N.43. *W. OREGON: Captive larvae (spring) avidly accepted snowberry, *Symphoricarpos rivularis* Suksd.—CAPRIFOLIACEAE (1962).

Behrensia conchiformis suffusa Buckett (det. J. S. Buckett). *SW. CALIF.(A): Larvae (spring) feed at night on the large and widely-spaced young lvs. of rank, fast-growing (young) stems of chaparral honeysuckle, *Lonicera subspicata* var. *johnstonii* Keck—CAPRIFOLIACEAE (1955). (See also *Pleroma cinerea*.)

Callierges tropicalis Schaus? (det. BB)—N.55. *W. OREGON: Larvae (Sept.-Oct.) feed at night on lvs. of (only) St. John's wort, **Hypericum perforatum* L.—CLUSIACEAE (1962). (See also *Zosteropoda*.)

Catabena lineolata Walk. (det. LM)—N.11. *SW. CALIF.(A): Larvae (spring-summer) on lvs. of wild verbena, *Verbena lasiostachys* Link.—VERBENACEAE (1954).

Catocala verrilliana beutenmulleri B. & McD. (det. BB)—N.70. *W. OREGON: Captive larvae (spring) avidly accepted young lvs. of *Quercus garryana* Dougl.—FAGACEAE (1962).

Copicucullia jemezensis Dyar (det. JD, 1972).—N.90. *SW. CALIF.(A): Larvae (spring-summer) alternating (irregularly) between both of the following, but usually predominating on only one of these two plants in any given year: *Corethrogyne filaginifolia* (H. & A.) Nutt. (var. ?) and *Haplopappus (Hazardia) squarrosus* ssp. *grindeloides* (DC) Keck—both ASTERACEAE (1955). Note: This same information was wrongly reported by McFarland (1965) under the name "*Cucullia ?laetifica* Lint."

Cucullia ?intermedia Speyer (det. JD)—N.79. CALIF., San Bernardino Co., Mojave Desert, Granite Mts., about 4 mi. NE of Apple Valley: Larvae (Nov.) on desert aster, *Machaeranthera tortifolia* (Gray) Cronq. & Keck—ASTERACEAE (1963).

Euclidina ardita Franclemont (det. NM). *SW. CALIF.(A): Captive larvae (spring) avidly accepted lvs., buds, and fls. of deerweed, *Lotus scoparius* (Nutt. in T. & G.) Ottey—FABACEAE. I often observed the diurnal female adults fluttering over and around this plant, but never observed them actually ovipositing (1950 +).

Eupsilia fringata B. & McD. (det. LM)—N.73. CALIF., Los Angeles Co., nr. Jackson Lake, about 5-6 mi. WNW of Wrightwood (6300' \pm elev.): Larvae (June) in silk-tied leaf-nest shelters on a goldenrod, *Solidago* sp.—ASTERACEAE; a disturbed roadside habitat. I am indebted to Mr. C. Henne for bringing to my attention these striking velvet-black larvae (1963).

Feralia deceptiva McD. (det. BB)—N.44. *W. OREGON: Captive larvae (April) readily accepted young lvs. (only) of Douglas fir, *Pseudotsuga menziesii* (Mirb.) Franco.—PINACEAE (1962).

Gerra seversa (Grote) (det. JD)—As.3. ARIZ., Cochise Co., Chiricahua Mts., at the Southwestern Research Station (\pm 5000'): Larvae (Aug.) abundant on a creeper, *Parthenocissus* sp., and wild grape, *Vitis arizonica* Engelm.—both VITACEAE (1963).

Lycanades pulchella Sm. (det. BB)—N.59. *W. OREGON: Captive larvae (April) avidly accepted young lvs. of the commonest local wild blackberry, *Rubus* sp.—ROSACEAE (1962). A number of the resultant pupae were given to J. G. Franclemont.

Magusa orbifera Walk. (det. LM)—N.76. ARIZ., Cochise Co., Chiricahua Mts., between Portal and the Southwestern Research Station (\pm 4700'), along the roadside: Larvae (Aug.) defoliating *Rhamnus betulaeifolia* Greene—RHAMNACEAE (1963).

Marathyssa inficita minus Dyar (det. LM)—N.30. *SW. CALIF.(B): Captive larvae (July) avidly accepted mature lvs. of *Rhus trilobata* var. *anisophylla* (Greene) Jeps.—ANACARDIACEAE (1961).

Oncocnemis astrigata B. & McD. (det. JD)—N.89. *SW. CALIF.(B): Larvae (May) on *Cercocarpus betuloides* Nutt. ex T. & G.—ROSACEAE; obtained by beating (1964).

Oncocnemis ragani Barnes (det. LM)—. *SW. CALIF.(A): Larvae multiple-brooded (spring-summer) on chaparral honeysuckle, *Lonicera subspicata* var. *johnstonii* Keck—CAPRIFOLIACEAE (1956).

Oncocnemis singularis B. & McD. (det. CH). *SW. CALIF.(A): Larva (June) on fl. buds and fls. of *Keckiella* (= *Penstemon*) *cordifolia* (Benth.)—SCROPHU-

LARIACEAE. Chris Henne kindly carried this rearing through to completion for me, after I had left the U.S.A. (1964).

Orthosia ferrigera SM. (det. BB)—N.69. *W. OREGON: Captive larvae (April) avidly accepted new lvs. of *Quercus garryana* Dougl.—FAGACEAE (1963).

Orthosia garmani Grt. (det. JF)—N.26. KANSAS, Douglas Co., 7 mi. NE of Lawrence, Univ. of Kans. Natural History Reservation: Captive larvae (April) readily accepted *Cornus asperifolia* Michx.—CORNACEAE, *Fraxinus* sp.—OLEACEAE, and *Ulmus americana* L.—ULMACEAE (1961).

Panthea portlandia Grt. (det. BB)—N.52. *W. OREGON: Captive larvae (Aug.) avidly accepted mature lvs. of Douglas fir, *Pseudotsuga menziesii* (Mirb.) Franco.—PINACEAE (1962).

Pleroma cinerea Sm. (det. LM). *SW. CALIF.(A): Larvae (spring) feed at night on the large young lvs. of the rank, fast-growing (young) stems of *Lonicera subspicata* var. *johnstonii* Keck—CAPRIFOLIACEAE (1955). By day they rest low down among the woody stems. (See also *Behrensia conchiformis suffusa*.)

Pleroma conserta Grt. (det. BB)—N.39. *W. OREGON: Captive larvae (April) avidly accepted *Symphoricarpos rivularis* Suksd.—CAPRIFOLIACEAE (1962).

Pleroma obliquata Sm. (det. BB)—N.53. *W. OREGON: Captive larvae (April) avidly accepted *Symphoricarpos rivularis* Suksd.—CAPRIFOLIACEAE (1963).

Pleromella opter Dyar (det. LM)—N.82. *SW. CALIF.(B): Captive larvae (spring) avidly accepted young lvs. (only) of *Arctostaphylos glauca* Lindl.—ERICACEAE (1964).

Polychrisia morigera Hy. Edw. (det. T. D. Eichlin, 1972)—N.66. *W. OREGON: Larvae locally abundant (April), in a low-lying streamside habitat, inside distinctive cut-leaf-nests on *Delphinium trolliifolium* Gray—RANUNCULACEAE (1963). This moth is apparently well established in the above locality, but adults were never taken at incandescent or ultraviolet lights while I was collecting there. Had I not discovered the larvae, I would never have suspected the presence of this species.

Provia argentata B. & McD. (det. CH)—N.87. CALIF., Los Angeles Co., 4–5 mi. S of Pearlblossom, near N base of San Gabriel Mts. (\pm 4000'–4200'): Larvae (May) on the woody shrub, *Purshia glandulosa* Curran—ROSACEAE; obtained by beating (1964). A very colorful larva, marked with vivid red and pure white over a translucent green ground-color. Chris Henne kindly completed this rearing for me, from pupa to adult.

Pseudocopivaleria anaverta Buckett & Bauer (det. BB)—N.83. *SW. CALIF.(B): Larvae (spring) on young lvs. of *Quercus chrysolepis* Liebm.—FAGACEAE (1964).

Raphia frater Grt. (det. BB)—N.51. *W. OREGON: Captive larvae (summer) readily accepted *Populus* spp.—SALICACEAE (1962).

Rhodophora gaurae A. & S. (det. NM)—N.16A. ARIZ., Cochise Co., near Portal: Larvae (Aug.) on inflorescences of *Gaura parviflora* Dougl. ex Hook.—ONAGRACEAE (1963).

Schinia trifascia Hbn. (det. JF)—N.15. KANS., Douglas Co., 7 mi. NE of Lawrence, near the Univ. of Kansas Natural History Reservation, along roadside: Larvae (Sept.) in fl. heads of *Eupatorium altissimum* L.—ASTERACEAE (1960).

Triocnemis saporis Grt. (det. CH)—N.86. CALIF., Los Angeles Co., near Valyermo, Bob's Gap: Larvae (May) on fl. buds and fls. of the small annual, *Eriogonum pusillum* T. & G.—POLYGONACEAE (1964). These larvae are most distinctive in both appearance and behavior.

Xylomyges februalis B. & McD. (det. BB)—N.45. *W. OREGON: Captive larvae (April) avidly accepted young lvs. of *Quercus garryana* Dougl.—FAGACEAE (1962).

Zosteropoda hirtipes Grt. (det. NM)—N.58. *W. OREGON: Larvae (autumn) feeding at night on **Hypericum perforatum* L.—CLUSIACEAE (1962). (See also "Callierges.")

NOTODONTIDAE

Dicentria pallida Stkr. (det. BB)—Nd.8. *W. OREGON: Larvae (autumn) on *Alnus oregona* Nutt.—BETULACEAE (1961).

Gluphisia severa Hy. Edw. (det. BB)—Nd.12. *W. OREGON: Captive larvae (May) readily accepted *Populus* spp.—SALICACEAE (1963).

Pheosia portlandia Hy. Edw. (det. BB)—Nd.10. *W. OREGON: Captive larvae (summer) readily accepted Lombardy poplar, **Populus nigra* var. *italica* DuRoi—SALICACEAE (1962).

PLUTELLIDAE

Trachoma walsinghamella Busck. (det. JD)—27(M). CALIF., Los Angeles Co., 4–5 mi. S of Pearblossom, near N base of San Gabriel Mts. ($\pm 4000'$ – $4200'$): Larvae (May) abundant on *Purshia glandulosa* Curran—ROSACEAE; by beating (1964).

PYRALIDAE

Jocara trabis (Grote) (det. LM)—Py.2(M). CALIF., San Bernardino Co., near Hesperia ($\pm 3200'$): Larvae (July) in conspicuous communal webs on *Eriogonum fasciculatum* Benth. var.?—POLYGONACEAE (1960).

Nephopteryx bifasciella Hulst (det. JC)—Py.15(M). *SW. CALIF.(B): Larvae (July) common on *Rhus trilobata* var. *anisophylla* (Greene) Jeps.—ANACARDIACEAE (1961).

SATURNIIDAE

Automeris pamina (Neum.) (det. LM)—St.12. (1) ARIZ., Cochise Co., Chiricahua Mts., at the Southwestern Research Station ($\pm 5000'$): Larvae (Aug.) on *Quercus* sp.—FAGACEAE (1963). (2) ARIZ., Coconino Co., nr. Jerome: Larvae (spring) on locust, *Robinia neomexicana* A. Gray—FABACEAE.

Hemileuca burnsi Wats. (det. LM)—St.15. CALIF., San Bernardino Co., Mojave Desert, Apple Valley, on sandy flats nr. the Apple Valley Inn ($\pm 2800'$): Larvae (spring) on the woody and spiny shrub, cotton thorn, *Tetradymia axillaris* A. Nels.—ASTERACEAE (1956).

Hemileuca electra clio B. & McD. (det. LM)—St.14. CALIF., San Bernardino Co., Mojave Desert, Apple Valley, on rocky hillside behind the Apple Valley Inn ($\pm 2800'$): Larvae (spring) on *Eriogonum fasciculatum* Benth. var. *polifolium* S. Stokes—POLYGONACEAE (1955).

Saturnia (= *Calosaturnia*) *albofasciata* (Johnson) (det. LM)—St.13. *SW. CALIF.(B): Larvae (May) by beating, and pale salmon-tan cocoons (July–Oct.) by searching, on birchleaf mahogany or hard tack, *Cercocarpus betuloides* Nutt. ex T. & G.—ROSACEAE; this appears to be a “preferred” or normal foodplant in the locality concerned, although *Ceanothus* spp. (RHAMNACEAE) and *Fremontia* (STERCULIACEAE) may also be involved here (1964). See Hogue et al. (1965).

SPHINGIDAE

Sphinx perelegans Hy. Edw. (det. BB)—Sp.12. *SW. CALIF.(B): Larvae (summer) on both *Cercocarpus betuloides* Nutt. ex T. & G.—ROSACEAE, and big-berry manzanita, *Arctostaphylos glauca* Lindl.—ERICACEAE (1964).

STENOMIDAE

“Antaeotricha” leucillana (Zeller) (det. JD)—Sn.10(M). KANSAS, Douglas Co., 7 mi. NE of Lawrence, nr. Univ. of Kans. Nat. Hist. Reservation: Larvae (Sept.) on *Cornus asperifolia* Michx.—CORNACEAE (1960).

THYATIRIDAE

Pseudothyatira cymatophoroides (Gn.) (det. BB)—Th.3. *W. OREGON: Larvae (autumn) on *Alnus oregona* Nutt.—BETULACEAE; also on *Corylus* sp.—CORYLACEAE (1962–63).

ZYGAENIDAE

Tripocris smithsonianus Clemens (det. JD)—Zy.2. NEW MEXICO, Socorro Co., about 20 mi. N of Socorro, in sand dunes west of the highway: Larvae (June) on lvs. of a sand verberna, *Abronia* sp.—NYCTAGINACEAE (1961). Damage to foodplant lvs. is rather lycaenid-like, as is the general appearance of the larvae at first glance.

REMARKS

Some foodplant records had to be omitted from the present list because the adult moths involved still remain unidentified. However, it will be noted that I have included a few foodplant records where the moths involved are NOT fully determined; see the three *Tolyte* spp. (Lasiocampidae), for example. In these particular cases the value of the *foodplant* information offsets the uncertainty over indefinite specific determinations. In the three localities concerned, it appears that only one species of *Tolyte* occurs in each place—almost certainly so in the case of “*SW. CALIF. (A).” In that locality I resided for 20 years, and undertook serious collection and observation of Lepidoptera there from about 1946–1958. It took repeated trials, over several years, to discover *any* foodplant acceptable to the local *Tolyte*; I therefore feel that this is valuable and hard-earned information—even though the moth involved has not been identified to species with certainty! There is no other moth with which it could be confused in the locality named.

Another example and perhaps the most extreme of these cases is the noctuid, “*Callierges tropicalis* Schaus?” (my N.55). In view of its *most* distinctive preference for *Hypericum perforatum*, an important weed in some districts, the record seems of particular value to bring to the attention of other workers. Positive identification of this moth could no doubt eventually be clarified by anyone sufficiently interested. (Specimens have been sent to several taxonomists since 1962, with little agreement forthcoming as to the correct identity! It is a fairly common insect in the locality named.)

Some of the foodplant genera reported here are already well-known records; such records are included only where I have been able to provide the *additional* information of identified foodplant species (for specific localities) which warrant reporting (Shields, et al., 1970). When the foodplant could not be *fully* identified, the records were (mostly) omitted, except for a few where it seemed of considerable interest to

report merely the foodplant genus. None of the foodplants named in this paper were collected and deposited in herbaria (as was wisely recommended by Shields, et al.). However, I am willing to provide (where possible), through correspondence, whatever additional information might be needed by other workers to facilitate continuing work on any of the larvae or foodplants mentioned in this paper.

In our rapidly-deteriorating environment it is becoming ever more urgent that all lepidopterists having unpublished life history knowledge should get busy (soon!) and make known, through publication, at least their accurate foodplant records or brief habitat notes, thus rendering this information quickly *available to others*, instead of merely storing it up to carry to the grave! (I realize that such admonitions do not apply to all, but there are few among us who cannot name cases where they most definitely do apply.) ANY clues to larval foodplants are tremendous aids and a great encouragement to the continuing advancement of life history investigations. Entire habitats are in the process of disappearing. Others are now mere remnants. The chances for studying (or even revisiting) some of these places can already (1973), be classed as opportunity irreversibly lost.

ACKNOWLEDGMENTS AND DETERMINATIONS

I am indebted to William Bauer and Steve Buckett (Davis, California—"det. BB") and Lloyd M. Martin (formerly of the Natural History Museum of Los Angeles County, Calif.—"det. LM") for their help in naming most of the adult moths associated with these larval foodplant records; to J. F. G. Clarke (Smithsonian Institution, Washington, D.C.—"det. JC"), J. P. Donahue (Natural History Museum of Los Angeles County—"det. JD"), J. G. Franclemont (Cornell University, Ithaca, N.Y.—"det. JF"), Christopher Henne (Pearblossom, Calif.—"det. CH"), the late Carl W. Kirkwood (Summerland, Calif.—"det. CK"—Geometridae) and Frederick Rindge (American Museum of Natural History, N.Y.—"det. FR"—Geometridae) for their help with a number of the remaining adult determinations. Moths designated as "det. NM" were determined by the author. Most of these determinations are based on known adults. I would like to thank Christopher Henne, Charles L. Hogue and J. P. Donahue for reviewing this manuscript in 1973, and for offering various helpful criticisms; my wife, Dienie, for typing it.

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GENERAL NOTES

BUTTERFLIES OBSERVED IN SIECHE HOLLOW STATE PARK,
SOUTH DAKOTA

Sieche Hollow's 887 acres, in Marshall and Roberts counties in northeastern South Dakota, were added to the South Dakota State Park system in 1971. The park is comprised of a very moist wooded valley and one of the best examples of virgin tallgrass prairie remaining in the state. The picturesque valley is cut by a spring fed creek which runs the year around and has created a cool, lush, deciduous woodland entirely unlike the surrounding South Dakota plains. The preserved prairie stand is surrounded on three sides by the "U" shaped valley and probably is very similar to what most of the entire region looked like before the sod was turned by early settlers.

I visited Sieche Hollow four times during the summer of 1972 and found it a very interesting locality for butterflies. A list of the species that I observed there seems worth noting because it is a unique locality and there is only one published local list of South Dakota butterflies (Truman 1896, Ent. News 7: 289-299; 8: 27-29). Possibly my publication will encourage others to do further collecting there.

A list of the species that I observed at Sieche Hollow on four collecting trips (late May, mid-June, early August and mid-August 1972) follows:

PAPILIONIDAE

Papilio polyxenes Fabricius. Prairie area, scarce.

Papilio glaucus Linnaeus. Woodland, not uncommon.

PIERIDAE

Pieris rapae (Linnaeus).

Colias eurytheme Boisduval.

Colias philodice Godart.

Euchloe olympia (Edwards). One worn example in wooded area, May.

DANAIIDAE

Danaus plexippus (Linnaeus).

SATYRIDAE

Lethe anthedon (Clark). Wooded area, scarce.

Euptychia cymela (Cramer). Woodland, common.

Coenonympha tullia Muller. Scarce, prairie in July.

Cercyonis pegala (Fabricius). Prairie, late summer.

Oeneis uhleri (Reakirt). Prairie, uncommon in May.

NYMPHALIDAE

Asterocampa celtis (Boisduval & Le Conte). Woodland, uncommon.

Limenitis archippus (Cramer). Several along road into park.

Limenitis arthemis (Drury). Common in woodland and edge of prairie. Population here is hybrid *L. arthemis/astyanax*.

Vanessa atalanta (Linnaeus).

Vanessa cardui (Linnaeus).

Nymphalis antiopa (Linnaeus). Several sight records, woodland.

Polygonia comma (Harris). One example, woodland.

Phyciodes tharos (Drury). Very common.

Chlosyne nycteis (Doubleday). Scarce.

Chlosyne gorgone (Hübner). On prairie, May and August.
Speyeria idalia (Drury). Very common on prairie, July and August.
Speyeria cybele (Fabricius). Common.
Speyeria aphrodite (Fabricius). Fairly common on prairie.

LYCAENIDAE

Harkenclenus titus (Fabricius). Prairie, not uncommon.
Feniseca tarquinius (Fabricius). Along stream bed, two examples, June.
Lycaena thoe Guerin-Meneville. Prairie area, scarce.
Lycaena xanthoides (Boisduval). Prairie area, very common.
Lycaena helloides (Boisduval). On prairie, uncommon, August.
Hemiargus isola (Reakirt). One example on prairie, August.
Lycaeides melissa (Edwards). Very common on prairie.
Everes comyntas (Godart). Common everywhere.
Glauopsyche lygdamus (Doubleday). May, on the area where the prairie and woodland meet. This is probably the most surprising find here, the population appears to be different from both the eastern woodland ssp. *couperi* Grote and the ssp. *oro* which is found in the Black Hills of western South Dakota. It is not uncommon here.

Celastrina argiolus (Linnaeus). Woodland, scarce.

Complete records of skippers (Hesperiidae) were not kept. One species that I had particularly hoped to find on the prairie here, *Hesperia dacotae* (Skinner), was not seen. *Hesperia uncas* Edwards was not seen either but probably occurred on the prairie during July. Species of Hesperidae that were encountered included *Poanes hobomok* (Harris), *Polites coras* (Cramer), *Polites mystic* (Scudder), *Polites themistocles* (Latreille), *Hesperia pawnee* Dodge, and *Erynnis juvenalis* (Fabricius).

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A CORRECTION

Recent reply to my article entitled "Two New *Thecla* from the Continental United States" (J. Lepid. Soc., 28: 305) proves the statements regarding *Chlorostymon simaethis* (Drury) to be not only false but a disaster to the literature. It has been pointed out to me that *C. simaethis* is widely distributed in the Antillean area and that the appropriate subspecific assignment to that found in Florida is currently under study by Mr. Steve Roman, Casselbury, Florida (*pers. comm.*). He discovered the species in that state in 1970. However, a check of past season summary reports in the News of the Lepidopterists' Society shows the record was not reported for Florida. The error is blamed on my overlooking several appropriate sources of literature on the fauna of the Antillies (which goes to show, no matter how small the article, a literature research should be thoroughly undertaken) and also a lack of inquiry and communication with individuals with access or personal records on the species involved in the article. It should also be noted that I am aware of the fact that *Electrostymon angelia angelia* (Hewitson) is correctly spelled in that manner and not "*angelica*" as it appears in the article.

It is hoped this note will prevent future mistakes such as this from happening and perhaps promote a more fluid exchange of information between collectors and researchers alike.

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NEW RECORDS OF LEPIDOPTERA FROM MEXICO (SPHINGIDAE, SATURNIIDAE)

Since Hoffman's catalogue of Mexican Sphingoidea and Saturnioidea (1942, Anal. Inst. Biol. (México) 13: 213-256), several other species have been recorded from Mexico (Vazquez, 1965, Anal. Inst. Biol. Univ. Nac. Autón. México 26(1-2): 203-213; Vazquez & Beutelspacher, 1967, Anal. Inst. Biol. Univ. Nac. Autón. México 38, Ser. Zoo. (1): 75-77; Beutelspacher & de la Maza, 1973, J. Lepid. Soc. 27: 303-304). We recently found two additional species of Sphingidae, *Eumorpha phorbas* (Cr.) and *Xylophanes zurcheri* (Drce.); and two Saturniidae, *Citheronia collaris* Rothsch. and *Sphingicampa bicolor* (Harr.). The systematic arrangement is according to Hodges (1971, in R. B. Dominick et al. The moths of America north of Mexico, fasc. 21, Sphingoidea) and Ferguson (1971-72, in R. B. Dominick et al. The moths of America north of Mexico, fasc. 20.2, Bombycoidea, Saturniidae).

SPHINGIDAE

Eumorpha phorbas (Cr.). The previously known geographic distribution for this species is Venezuela, Surinam, Para and Trinidad (Draudt, 1920). In Mexico the species was collected at the following localities: 1 ♂, 1 ♀, Dos Amates, Veracruz, May 1969; 1 ♂, Colonia, Teniaco, Veracruz, Sept. 1969; and 1 ♂, Bonampak, Chiapas, May 1970. All specimens were collected by Dr. Tarsicio Escalante and are in his collection.

E. phorbas should be inserted after *E. fasciata* (Sulzer) in Hoffman's catalogue.

Xylophanes zurcheri (Drce.). Druce (1886, Page 301, pl. 46 in Godman & Salvin, Biologia Centrali-Americana, Insecta, Lepidoptera, Heterocera, 2) and Draudt (1929, in A. Seitz, Die Gross-Schmetterlinge der Erde, 6) gave Costa Rica as the only locality. In Mexico the species was collected at Puerto Eligio, Oaxaca Istmo de Tehuantepec, 25 & 29 Sept. and 10 & 11 Oct. 1961 by Escalante.

In Hoffman (1942), *X. zurcheri* should follow *X. juanita* R. & J.

SATURNIIDAE

Citheronia collaris Rothsch. Draudt (1929, in A. Seitz, Die Gross-Schmetterlinge der Erde, 6) registered this species only from Ecuador and Colombia. The localities for Mexico include: 1 ♂, Los Tuxtlas area, Veracruz, 18 June 1963 and 1 ♂, Dos Amates, Catemaco, Veracruz, 23 April 1968, collected by Sr. Roberto de la Maza and deposited in his collection; and 1 ♂, Estación de Biología Tropical "Los Tuxtlas," Veracruz, 15 March 1969, collected by Dr. Carlos R. Beutelspacher and deposited in the Entomological Collection of the Instituto de Biología, Universidad Nacional Autónoma de México.

This species should be placed after *C. beledonon* Dyar in Hoffman's catalogue.

Sphingicampa bicolor (Harr.). According to Ferguson (1971-72) this species occurs in Canada and the U.S.A. Reported for the first time from Mexico are 5 ♂♂, El Barrial, Nuevo León, 10 Sept. 1971, collected by de la Maza and deposited in his collection.

This species should precede the entry of *S. heiligbrodti* in Hoffman's catalogue.

S. hubbardi (Dyar). Dyar ("1902" [1903], Bull. U.S. Natl. Mus. 52: 76) described *hubbardi* as a subspecies of *Syssphinx heiligbrodti* (Harv.), but Ferguson (1971-72) recognized it as a species and transferred it to the genus *Sphingicampa*. Ferguson also published the first records of its occurrence in Mexico. The record of the capture of a male in San Luis Potosi, 20 June 1964 by de la Maza is offered to supplement Ferguson's information.

In Hoffman's catalogue this species must be situated after *heiligbrodti* Harv.

ACKNOWLEDGMENT

We express our thanks to Dr. Tarsicio Escalante for allowing us to study his material.

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NOTES ON SOME SKIPPERS (HESPERIIDAE) FROM
SOUTHEASTERN GEORGIA

On the morning of 18 May 1974, I stopped to collect for about 30 minutes along U.S. Route 82 in Atkinson Co., Georgia, two mi. E of Pearson. I was compelled to stop by the sight of a skipper collector's delight: profusely blooming Pickerel Weed (*Pontederia cordata* Linn.) lining both sides of the highway in shallow drainage ditches. I collected only nine butterflies (six species) because others were too far over the water for me to reach dry-shod. I later checked on the status of knowledge of each species in Lucien Harris Jr.'s *Butterflies of Georgia* (1972). I found that the five skipper species were new county records, and that some were considered rather rare. I present here a list of these species and comments from Harris (1972) as well as my own:

1. *Oligoria maculata* (Edwards), Twin-spot Skipper. Harris (p. 38) states that it is "not usually common." My two specimens were a bit worn, but were taken within date ranges given by Harris.
2. *Euphyes dion alabamiae* (Lindsey), Alabama Skipper. My fairly fresh pair adds a sixth county to the list for Georgia; Harris (p. 49) indicates that *alabamiae* "occurs widely in the Coastal Region."
3. *Euphyes berryi* (Bell), Berry's Skipper. The capture of two males was the prize of this collection because I had never collected it before, and also because this locality extends the known range in Georgia somewhat to the south and west (Bryan, Screven, and Effingham comprise the previously known range in Georgia). Harris (p. 50) refers to it as "rare and local."
4. *Poanes aaroni howardi* (Skinner), Aaron's Skipper. I took one male in good condition, and saw others. Harris (p. 56) gives no Coastal Region records, listing it only from Augusta in Richmond Co. Furthermore, this capture is the first from Georgia representing the May brood (the Augusta specimens were taken in August).
5. *Atrytone delaware delaware* (Edwards), Delaware Skipper. According to Harris (p. 65), *delaware* "occurs widely but locally in Georgia, and is generally rare." I took a fresh male.

The only other butterfly collected was *Phyciodes phaon* (Edwards), netted on the shoulder of the highway rather than amid the Pickerel Weed blossoms.

This collection information bears out the fact that some butterfly species are listed as rare in publications largely because no one has collected in the right places at the right times to justify any other conclusion. I am surprised that more people have neglected southeastern Georgia—the land of John Abbot—in their collecting plans. I expect to give the area more attention in the future.

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RECENT DONATIONS OF LEPIDOPTERA TO THE
NATURAL HISTORY MUSEUM OF LOS ANGELES COUNTY

During the past three years (1972-1974) four major private collections of Lepidoptera, totaling over 86,000 specimens, have been donated or permanently loaned to the Natural History Museum of Los Angeles County. All this material is being incorporated into the general collection after receiving distinctive labels where necessary.

Carl W. Kirkwood, who died on 3 March 1972 at his home in Summerland, California, amassed one of the largest private collections of North American geometrid moths in history, containing 1,220 species, or 86% of the known fauna. The collection consists of 33,720 specimens, all but 1,700 of which are fully prepared and identified, and includes 355 paratypes. A valuable part of this collection consists of 2,060 associated genitalic slides, as well as 13 loose-leaf notebooks with typed copies of the original descriptions of all 1,416 North American species, plus the descriptions of all subspecies and synonyms. With the accession of this material the Natural History Museum is now one of the largest repositories of North American Geometridae.

Edwin Ray Hulbirt gave his worldwide collection of Lepidoptera to Citrus College, Azusa, California, in January 1963 (see Comstock, John A., "Edwin Ray Hulbirt (1886-1965)," *J. Lepid. Soc.* 19: 243-244, 1965). In late 1972 Citrus College, faced with a shortage of storage and exhibit space, transferred the entire collection, except for some specimens without data, to the Natural History Museum as a permanent loan. Hulbirt was particularly interested in the Hesperiidae and Lycaenidae, although he exchanged for all groups of butterflies, and some moths, with other collectors throughout the world. His collection, consisting of 19,340 specimens (over 14,000 of them spread and labeled), is especially valuable in that it greatly strengthens our growing collection of "exotic" Lepidoptera.

Oscar E. ("Elton") Sette was a very active butterfly collector until his death in July 1972. Most of his specimens are from California localities, including several, such as the foothills adjacent to Chula Vista in San Diego County, which have been virtually destroyed by "development." Sette compiled three volumes of notes on the locality or source of every specimen added to his collection, and each locality label on the specimens bears a number referring to these notes. The Sette Collection, particularly rich in Lycaenidae and Hesperiidae, consists of 22,476 butterflies, of which 11,039 are fully prepared, with the balance in papers.

Munroe L. Walton, of Glendale, California, was perhaps better known for his enormous collection of North American land snails than for his impressive collection of Lepidoptera. Following his death at the age of 84 on 18 July 1974, the insects were donated to the Natural History Museum. This collection, consisting almost entirely of California material, contains virtually every species and subspecies of butterfly known from the state. Of the 10,472 specimens of Lepidoptera, all of which are immaculately prepared, 6,190 are butterflies. Particularly well represented in this collection are the Noctuidae (2,470 specimens), Nymphalidae (2,087 specimens, of which 577 are *Euphydryas*), and Lycaenidae (1,795 specimens, including 73 specimens of the extinct *Xerces Blue*).

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SHEPPARD, P. M. 1959. Natural Selection and Heredity. 2nd. ed. Hutchinson, London. 209 p.

——— 1961a. Some contributions to population genetics resulting from the study of the Lepidoptera. Adv. Genet. 10: 165-216.

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JOURNAL

of the

LEPIDOPTERISTS' SOCIETY

Published quarterly by THE LEPIDOPTERISTS' SOCIETY

Publié par LA SOCIÉTÉ DES LÉPIDOPTÉRISTES

Herausgegeben von DER GESELLSCHAFT DER LEPIDOPTEROLOGEN

Publicado por LA SOCIEDAD DE LOS LEPIDOPTERISTAS



26 September 1975

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Memoirs of the Lepidopterists' Society, No. 1 (Feb. 1964) A SYNONYMIC LIST OF THE NEARCTIC RHOPALOCERA

by CYRIL F. DOS PASSOS

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JOURNAL OF THE LEPIDOPTERISTS' SOCIETY

Volume 29

1975

Number 3

ROSTROLAETILIA—A NEW NORTH AMERICAN GENUS OF THE SUBFAMILY PHYCITINAE, WITH DESCRIPTIONS OF SEVEN NEW SPECIES (PYRALIDAE)

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In his revision of the Anerastiinae (auctorum), Shaffer (1968) showed that this subfamily, which had been separated by Ragonot (1886) from the Phycitinae on the basis of a single reduction character, loss or extreme reduction of the tongue, was not monophyletic. On the basis of the genitalia, he showed that some genera should remain separate from the Phycitinae and be treated under the subfamily name Peoriinae, a name previously used in a much broader sense by Hulst (1890). The remainder of the Anerastiinae, including the genus *Anerastia* Hübner, were considered by Shaffer to belong to the Phycitinae.

For lack of sufficient information or material Shaffer left unplaced a few genera and species which he discussed briefly at the end of his revision. These are taxa that had not been treated by Heinrich (1956) because he thought that they were Anerastiinae and thus not within the scope of his revision of the Phycitinae. The present paper offers a redescription of three of these unplaced species, namely *Altoona ardiferella* Hulst, *Aurora nigromaculella* Hulst, and *Parramatta placidella* Barnes & McDunnough, as well as descriptions of seven new species. We were able to assign the three existing species names with confidence because the types are available, and their genitalia are distinctive. Our rediscovery of the holotype of *ardiferella* was particularly fortunate.

Hulst had said nothing about its location, but the specimen turned up in the Fernald Collection, acquired by the U. S. National Museum. On the basis of external structural characters and genitalia we believe that all ten species belong to the same genus, which we also describe as new.

The following generic names have been used for one or more of the three previously described species: *Altoona* Hulst, *Aurora* Ragonot, *Saluria* Ragonot, *Tolima* Ragonot, *Pectinigeria* Ragonot, *Parramatta* Hampson, and *Zophodia* Hübner. *Altoona* and *Aurora* were synonymized by Shaffer (1968) with *Peoria* Ragonot. The type-species of *Saluria* (*maculivittella* Ragonot), *Tolima* (*oberthurii* Ragonot), *Pectinigeria* (*macrella* Ragonot), and *Parramatta* (*ensiferella* Meyrick) were illustrated in color by Ragonot; all have the characteristic pattern and coloring of Peoriinae and do not appear to be closely related to the group of North American species treated in this paper. *Zophodia* as defined by Heinrich (1956) is obviously not closely related. None of these generic names can properly be used for the ten subject species.

Shaffer (1968) thought that the three named species, *ardiferella*, *nigromaculella*, and *placidella*, should probably be referred to *Laetilia* Ragonot pending a thorough study of *Laetilia* and allied genera. Heinrich (1956: 230) also remarked upon the relationship of these species to *Laetilia* in his discussion of that genus: "The genus as here defined is structurally a somewhat composite group but is, I think, a natural one, linking in one direction with *Rhagea*, *Zophodia*, and the cactus feeding phycitine genera and on another with two or three as yet undescribed genera of coccid feeders in the *Anerastiinae*."

This study is based on material in the Blanchard Collection and the collections of the U. S. National Museum of Natural History and the Los Angeles County Museum of Natural History. We are indebted to Mr. Julian P. Donahue of the latter institution for the loan of specimens.

We discovered two additional new species of *Rostrolaetilia* from southern California, but these are not described in the present paper because the available specimens were judged to be inadequate. Thus twelve species are known to exist, although only ten are described.

Rostrolaetilia Blanchard & Ferguson, new genus

Type-species: *Parramatta placidella* Barnes & McDunnough, 1918.

Labial palps porrect, downcurved, long, extending three to four eye diameters beyond front; from beneath seen to be in contact with each other for nearly all their length. **Tongue** absent. **Maxillary palps** small, squamous. **Antennae** pubescent, simple. **Forewing** smooth, broadest toward termen; maculation alike in both sexes; cell about two-thirds length of wing; R_1 and R_2 from cell, R_3 stalked with R_{3+4} , M_1 straight, M_2 and M_3 shortly stalked, Cu_1 from lower outer angle of cell, well separated from Cu_2 . **Hindwing** with cell about one-half length of wing, discocellular vein

curved or angled in, weak; Rs closely paralleling Sc to upper outer angle of cell where it becomes Rs + M₁; just beyond middle of wing Rs and M₁ separate, M₁ continuing to outer margin and Rs forming a short cross vein which unites with Sc; Sc + R forks about half way to outer margin; M₂ absent; M₃ from lower outer angle of cell, shortly stalked with Cu₁; Cu₂ from before lower outer angle of cell.

Male genitalia: Uncus large, domelike, with a terminal process which may be very short and rounded, or triangular, or with parallel edges and either whole or indented or even bifurcate at apex; gnathos an arched or domelike structure, approximately parallel to uncus, from which two curved, tubular, arnlike processes extend toward the aedeagus and tend to embrace it; transtilla incomplete, represented by two separate, sclerotized plates dorsad of inner arms of gnathos; juxta a weakly sclerotized plate thickened and well defined along its anterior margin; valves simple, without extensions from sacculus or costa; in some species a weak sclerotization at basal margin of membranous part of valve; aedeagus short or medium, straight or slightly curved, smooth; vesica unarmed or with numerous small cornuti, often with a somewhat sclerotized, wrinkled surface.

Female genitalia: Bursa copulatrix smooth, with a narrow signum, ductus seminalis arising just caudad of signum; ductus bursae variable; sclerotization at ostium bursae variable; sclerotized collar of eighth segment interrupted middorsally where its ends are more or less infolded and support a membranous pocket.

We consider this genus to be related to *Laetilia* for the following reasons: a) Two reared specimens of *Rostrolaetilia* in the collection of the U. S. National Museum are labelled as having fed on coccoids of the genus *Orthezia* (Ortheziidae). It appears likely that species of this genus are predacious on Coccoidea as are the species of *Laetilia*. b) The gnathos, which has a surprisingly coherent structure in all of the known species, has obvious features in common with that of the genus *Laetilia*, particularly with *Laetilia coccidivora* (Comstock). c) The venation is extremely close to that of *Laetilia*. d) The structure of the transtilla is similar to that of the 21 genera listed between *Laetilia* and *Cactobrosis* in the sequence of Heinrich's (1956) revision.

Two obvious differences between *Laetilia* and *Rostrolaetilia* are the very different development of the labial palps, which in the latter genus are twice as long as those of *Laetilia*, and the tongue, which appears to be absent in *Rostrolaetilia*, rather well developed (and heavily scaled) in *Laetilia*. Also especially noteworthy is the clearly defined difference in the point of origin of the ductus seminalis in the female genitalia; this arises from the anterior end of the bursa copulatrix in *Laetilia* and from caudad of the signum in *Rostrolaetilia*.

KEY TO ADULTS BASED ON MALE GENITALIA

Note—Two species known from females only, *R. utahensis* and *R. coloradella*, cannot be identified with this key.

1. Sacculus clearly longer than one-half length of valve 2
 –Sacculus not or hardly longer than one-half length of valve 4
2. Process of uncus longer than its width at base, elongate-triangular, relatively slender, with a truncated or slightly emarginate apex 3

- Process of uncus not longer than its width at base, thickened, more nearly the form of an obtuse triangle that may appear truncated or notched at apex; Utah *placidissima*
3. Sacculus a long, bladelike triangle, its costal and ventral margins nearly straight; uncus slightly emarginate at tip (Fig. 21); S. Ariz. *nigromaculella*
- Sacculus very elongated but not triangular, its costal margin concave and ventral margin convex; uncus clearly truncated at tip (Figs. 19, 36); Texas *ardiferella*
4. Uncus without or almost without a process 5
- Uncus with a well-developed process, either pointed or bicuspidate at apex ... 6
5. Uncus without a process; arms of gnathos that tend to encircle aedeagus roundly spatulate and finely dentate at ends, their margins appearing fringed (Fig. 16) *minimella*
- Uncus with a very short, thickened process, appearing broadly truncated and trigonate in cross-section; arms of gnathos not as above *eureka*
6. Process of uncus pointed (Fig. 15); S. Calif. *placidella*
- Process of uncus bifid (Figs. 20, 22, 35); Texas, Ariz. 7
7. Process of uncus large, tapered, its width greater than one-half length of sacculus, and with its bifid tips blunt (Figs. 20, 35); Texas *texanella*
- Process of uncus small, the sides almost parallel, its width much less than one-half length of sacculus, and with the bifid tips pointed (Fig. 22); Ariz. *pinalensis*

KEY TO ADULTS BASED ON FEMALE GENITALIA

Note—*R. pinalensis*, known from the male only, cannot be identified with this key.

1. Ductus bursae rigidly sclerotized, at least in part 2
- Ductus bursae appearing entirely membranous (Fig. 28) *eureka*
2. Ductus bursae as long as or longer than corpus bursae, fully sclerotized, straplike, convoluted (Figs. 31, 37) *texanella*
- Ductus bursae shorter than corpus bursae, fully or partly sclerotized; if straplike, short and nearly straight, not convoluted 3
3. Ductus bursae fully sclerotized or nearly so, appearing flattened, nearly straight, the sides subparallel 4
- Ductus bursae partly sclerotized, less regular in form 5
4. Lamella postvaginalis distinctly tripartite, less than twice as wide as ductus bursae (Fig. 27) *coloradella*
- Lamella postvaginalis not distinctly tripartite, about twice as wide as ductus bursae (Fig. 26) *utahensis*
5. Ductus bursae sclerotized along left margin only, otherwise membranous (Fig. 25); Utah *placidissima*
- Ductus bursae sclerotized toward ostial end, membranous toward corpus bursae; widespread, Texas to California 6
6. Lamella antevaginalis and postvaginalis apparently fused into a single ostial plate with a very distinct, circular ostial opening (Figs. 30, 38) *ardiferella*
- Ostial plate not developed as above 7
7. Lamella postvaginalis developed as a large, well-sclerotized, funnel-shaped ostial plate fused to the rim of the ostium (Fig. 29) *nigromaculella*
- Lamella postvaginalis and antevaginalis, if present, separated, not fused to ostium or to each other 8
8. Lamella antevaginalis unsclerotized, apparently missing (Fig. 23) *placidella*
- Lamella antevaginalis present as a long, slender, almost linear transverse strip (Fig. 24) *minimella*

Rostrolaetilia placidella (Barnes & McDunnough)

Figs. 1, 13, 15, 23

Parramatta placidella Barnes and McDunnough, 1918: 177; pl. 24, fig. 17.

R. placidella, *minimella* and *placidissima* are superficially almost indistinguishable. *R. placidella* averages considerably larger than *minimella* and probably somewhat larger than *placidissima*. Also, *placidella* tends to lack the well-developed, subbasal dark spot at the inner margin commonly present in the other two species. These three species are the palest of the genus, their ground color being nearly white.

Maxillary palps blackish. **Labial palps** whitish, turning to dark brownish gray laterally. **Head, collar, thorax** and **tegulae** concolorous white with an ochreous tint. **Forewing** whitish, lightly sprinkled with black scales; a faint black dash at base, below which is an ochreous patch on inner margin extending nearly to antemedial line and continuing beyond antemedial line as a broad band which at times extends across entire median space, but which is generally confined to vicinity of antemedial line; this line white, rounded outwardly, becoming indistinct at costa where it merges into ground color, followed by a triangular black spot extending from radius almost to fold, generally connected to costa by thin outer border of antemedial line; this spot rests on ochreous shade already mentioned; preceding antemedial line on inner margin is a slight intensification of black sprinkling, forming a darker shade but no distinct spot; discal spot divided into two separate black dots, but one nearer costa usually obsolete; postmedial line white, bordered inwardly by a black line much thickened opposite cell, and outwardly by a faint intensification of black sprinkling starting from a triangular black spot at apex; terminal line incomplete, dotted; fringe pale inwardly, smoky outwardly. **Hindwing** white, in females lightly tinged with smoky brown. Beneath, **forewing** smoky with whitish apical patch traversed by a dark triangular streak; **hindwing** as above.

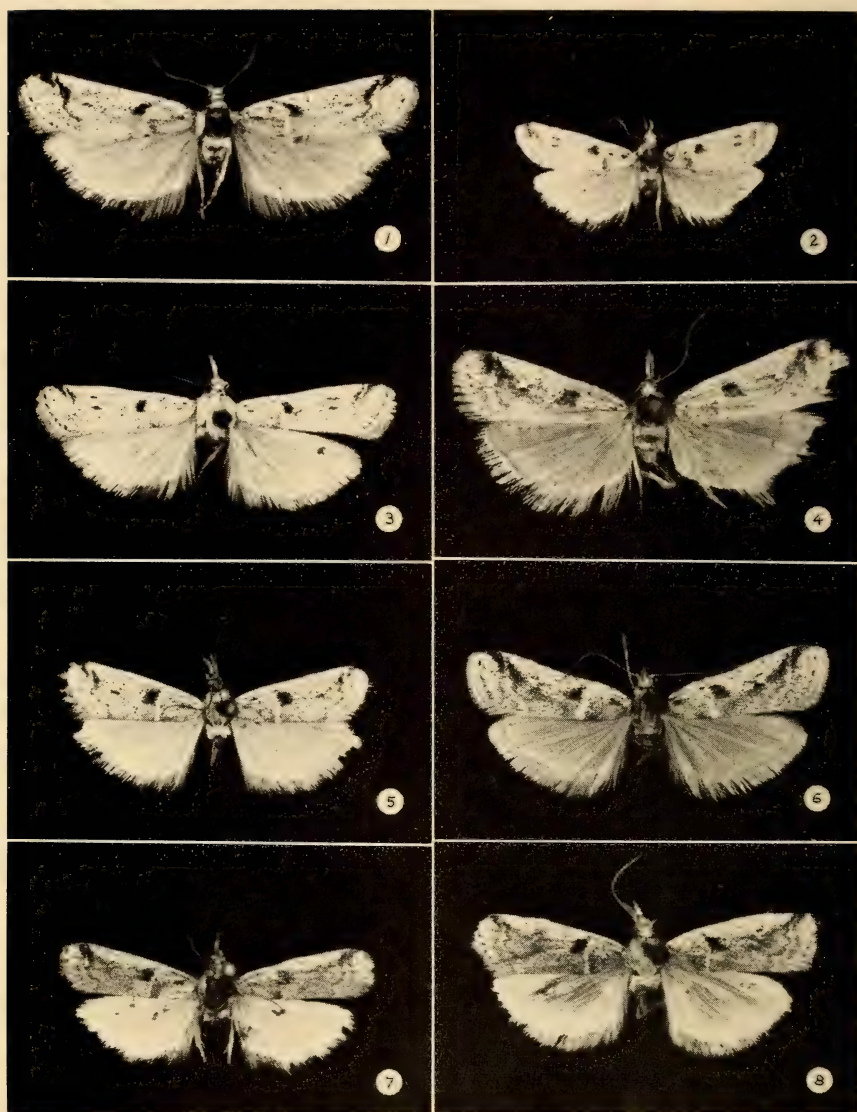
Wing expanse: Male 19.0 and 20.0 mm; female 15.5–22.0 mm.

Male genitalia (Fig. 15): Uncus with pointed, triangular apex; ventral margin of gnathos with deep medial indentation; inner armlike processes of gnathos gently curving around aedeagus, directed toward and almost reaching narrowly sclerotized base of juxta; valves simple, broadest at three-fourths their length from base; transtilla plates small; aedeagus short, stout; vesica armed with numerous minute cornuti; vinculum subtriangular with narrowly rounded terminal margin, about as long as its greatest width.

Female genitalia (Fig. 23): Corpus bursae about as long as tergum of seventh segment, greatest diameter about half the length, signum a small, transverse, double bar; ductus bursae short, somewhat thickened posteriorly; lamella postvaginalis triangular, barely sclerotized and not easily seen unless stained, filling a gap of same shape in collar; no lamella antevaginalis; dorsal, membranous pocket of collar trapezoid, broader caudad than cephalad, laterally limited by infoldings of collar.

Lectotype: Male (Fig. 1) from Olancho, Inyo Co., California, June 24–30, Barnes Collection, labelled “Parramatta placidella, Type, B. & McD.”, “Genitalia Slide USNM 52,462”, and “Slide No. 1127 Carl Heinrich, Feb. 6, 1942”, now in the U. S. National Museum, was designated as the lectotype by Shaffer (1968: 90).

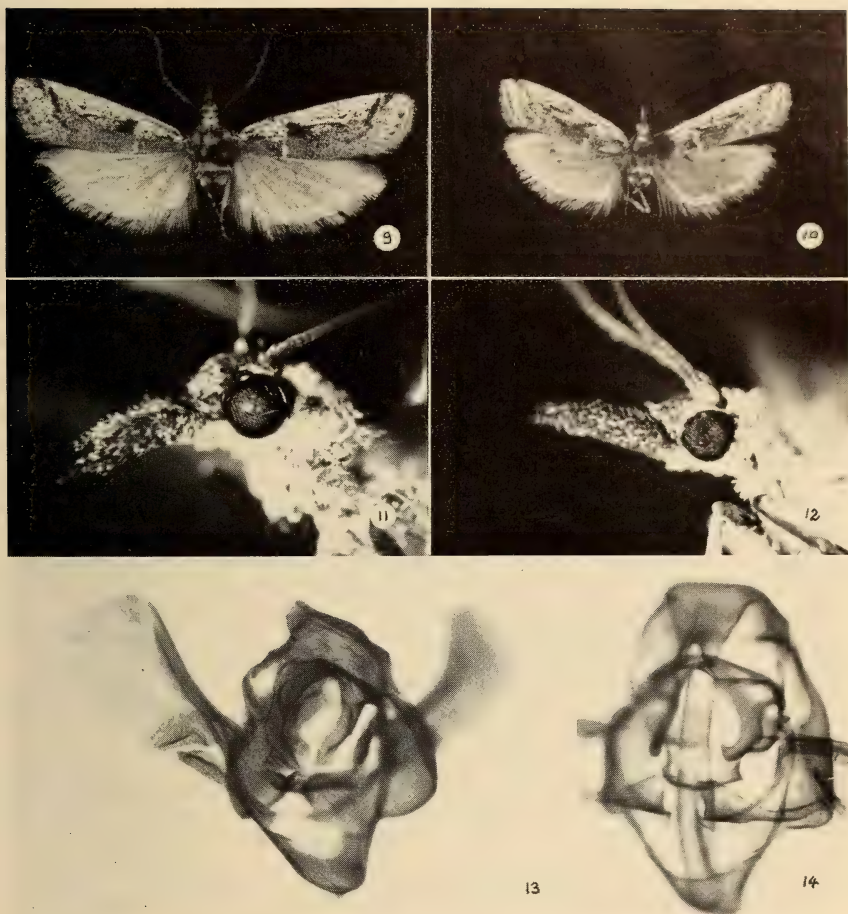
Paralectotypes: Four females from Olancho, Inyo Co., California, all labelled “Parramatta placidella Paratype B. & McD.”, “Barnes Collection”, now in the U. S. National Museum, were designated as paralectotypes by Shaffer (1968: 90). Three of these are dated June 8–15; the fourth, dated June 16–23, was dissected by Carl Heinrich (Slide 1128, Feb. 6, 1942). We dissected two of the females dated June



Figs. 1-8. *Rostrolaetilia* spp.: 1, *R. placidella*, lectotype; 2, *R. minimella*, holotype; 3, *R. placidissima*, holotype; 4, *R. utahensis*, holotype; 5, *R. coloradella*, holotype; 6, *R. eureka*, holotype; 7, *R. ardiferella*, holotype; 8, *R. nigromaculella*, holotype.

8-15 (USNM Slides 52450 and 52451). The female figured by Barnes and McDunnough (1918: pl. 24, fig. 17) is the undissected paralectotype.

One male and 29 females, also originally from the Barnes Collection and now in the U. S. National Museum, all from Olancha, California, were not included in the type series, probably because they were until recently unspread. They are mostly



Figs. 9-14. *Rostrolaetilia* spp.: 9, *R. texanella*, holotype; 10, *R. pinalensis*, holotype; 11, head and palps of *R. texanella*, and 12, *R. ardiferella*; 13, lateroventral view of male genitalia of *R. placidella*, and 14, *R. texanella*.

dated June 8-15, but some bear dates as early as May 8-15 and as late as July 8-15. Four more females are in the collection of the U. S. National Museum, three from Pasadena, Calif. (no dates), and one from Victorville, California, 19 May 1935. Of these 33 specimens, we dissected the unique male (USNM Slide 52378) and 16 females.

***Rostrolaetilia minimella* Blanchard & Ferguson, new species**

Figs. 2, 16, 24

The wing pattern and color of *R. minimella* are so similar to those of *R. placidella* that some specimens may be identified only by the

genitalia. *R. minimella* tends to be smaller, with the two discocellular spots about equally marked, the two subbasal dark spots adjoining the antemedial band also about equally developed, and the black lines defining each side of the postmedial band somewhat weaker, especially near costa. *R. placidissima* is also extremely similar and may be reliably distinguished only by the genitalia.

Wing expanse: Male, 13.5 mm; female, 14.0–17.0 mm.

Male genitalia (Fig. 16): Uncus almost without a posterior projection; gnathos with rounded posterior and angular anterior emarginations; tubular, inner armlike processes of gnathos embracing aedeagus midway between gnathos proper and juxta with spatulate extensions, finely denticulate at their margins; juxta with heavily sclerotized anterior margin over twice as broad as long; valves simple, broadly rounded; vinculum with broadly rounded terminal margin; aedeagus short; vesica armed with numerous minute cornuti.

Female genitalia (Fig. 24): Corpus bursae from one and one-half to two times as long as tergum of seventh segment, greatest diameter less than half the length; signum at midlength of corpus bursae, a crescent-shaped bar; ductus bursae short, somewhat contorted, thickened; ductus seminalis from just caudad of signum; ostium bursae wide, membranous, limited by narrow, sclerotized anterior and posterior lips; posterior lip forms a narrow, uninterrupted bridge between the ends of the collar; dorsal, membranous pocket of collar small, subtriangular, limited by incomplete infoldings of collar.

Holotype: Male, Olancho, Inyo Co., California, June 24–30, genitalia slide USNM 52377, Type No. 73,281 in collection of U. S. National Museum.

Paratypes: Olancho, California, April 24–30, 1 ♂; May 8–15, 1 ♀; May 24–31, 2 ♂♂; June 8–15, 5 ♀♀; June 24–30, 6 ♀♀. Yerma (in error for Yermo), California, 4 ♀♀. Sulphur, Nevada, June 21, 1962, 1 ♀.

A female labelled Dewberry Patch, Granite, Utah (Carl Heinrich's slide 1136), and two females reared from scale insects of the genus *Orthezia* at Mesilla Park, New Mexico, are probably conspecific with *R. minimella*; the genitalia are close, but it seems safer to leave them out of the paratype series.

***Rostrolaetilia placidissima* Blanchard & Ferguson, new species**

Figs. 3, 17, 25, 32

This species also is so similar to *R. placidella* that Barnes and McDunnough failed to recognize it as a different species. In the "Contributions" (1918: 177), they wrote immediately following the description of *placidella*: "We have several specimens from Stockton, Utah, one of which has been labelled '*ardiferella*' by Dr. Dyar." These specimens, two males and three females, are now in the collection of the U. S. National Museum. Heinrich dissected two males and one female; we dissected two females. We have also examined and dissected one male and three females in the Los Angeles County Museum. The forewing is somewhat paler than that of either *placidella* or *minimella*; the two discocellular dots are not of much help as they are equally well marked on two specimens and obsolescent on three. The forewings, which are

narrower than those of either *placidella* or *minimella*, offer the best differentiating character.

Wing expanse: Male, 15.5 and 18.5 mm; female, 16.5–21.0 mm.

Male genitalia (Fig. 17): Posterior edge of uncus produced in a subtriangular process, the apex of which appears as an inverted V covered with bristles; the almost hemispherical, dome-shaped part of gnathos is nearly cut in two by deep ventral and dorsal incisions; the edges of the dorsal incisions are expanded to form two parallel septa; the usual inner, armlike processes of the gnathos, which in other species of the genus embrace the aedeagus, are here represented by complicated but mostly laminar extensions; juxta with heavily sclerotized anterior margin; valves simple, narrowest at base of membranous portion; aedeagus short, stout; vesica armed with numerous minute cornuti (probably deciduous as they have disappeared in one of two Heinrich preparations); vinculum short with rounded terminal margin.

Female genitalia (Figs. 25, 32): Bursa copulatrix longer than tergum of seventh segment, diameter about three-fourths its length; signum a small, transverse bar ventrally located, nearer to junction of bursa with ductus bursae than to apex of bursa; ductus seminalis from just caudad of signum; ductus bursae short, thickened; lamella antevaginalis embracing almost half of the circumference of the collar; intersegmental membrane forming a depression between collar and lamella antevaginalis; lamella postvaginalis located in a subtriangular gap in the collar, with a semicircular emargination back of ostium bursae; collar longer than in other species of the genus; length about equal to diameter; membranous dorsal pocket of collar subtriangular, located in caudal half of collar, limited by deep, complete infoldings of collar.

Holotype: Male, Stockton, Utah, "IX.1.4", collected by Tom Spalding; Slide 1131, Carl Heinrich, 11 Feb. 1942 (labelled *Parramatta placidella*); USNM Slide 52,469; USNM Type No. 73,282.

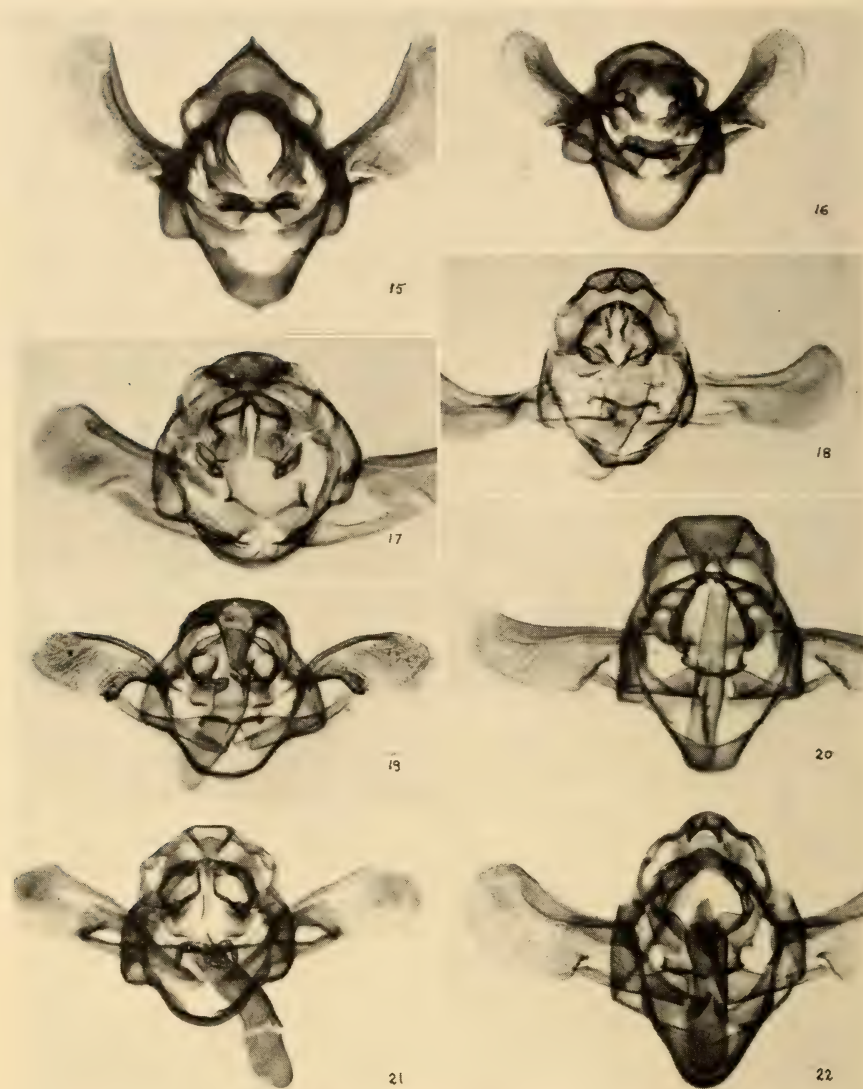
Paratypes: Argus Mts., Inyo Co., California, May 9, 1936, L. Martin, 1 ♂; near Topaz, Mono Co., California, July 15, 1937, 1 ♀; Independence, Inyo Co., California, May 14, June 13, 1936, 2 ♀♀; Stockton, Utah, 1 ♂, 3 ♀♀, all collected by Spalding. The dates on the labels of some of the Utah specimens are barely legible; the earliest appears to be 9 August 1904 and the others in early September 1904. The paratypes from California are in the Los Angeles County Museum of Natural History.

***Rostrolaetilia utahensis* Blanchard & Ferguson, new species**

Figs. 4, 26

R. utahensis is another of the larger species similar to *placidella* except that the dark subapical and subbasal markings are decidedly larger and more diffuse and the hindwings are slightly darker. The following description is of the female only; the male is unknown.

Labial palps pale ochreous gray above, varying beneath from white at base to blackish at apex; **head, collar, thorax** and **tegulae** whitish; **forewing** above whitish, very lightly sprinkled with blackish scales; antemedial line concolorous with wing, inwardly defined only by a squarish patch of blackish scales in lower half of basal space, outwardly by a sprinkling of blackish scales between costa and radius and a black square spot extending from radius to fold, resting on a square, pale ochreous patch reaching inner margin; this ochreous patch continues outwardly, becoming much paler in median space; postmedial band a wide white line between two poorly



Figs. 15-22. Male genitalia of *Rostrolaetilia* spp.: 15, *R. placidella*; 16, *R. minima*; 17, *R. placidissima*; 18, *R. eureka*; 19, *R. ardiferella*; 20, *R. texanella*; 21, *R. nigromaculella*; 22, *R. pinalensis*.

defined black borders; these borders, however, become very heavy near costa where each develops a black triangle pointing toward base of wing; lower discal dot minute, upper one obsolescent; terminal line poorly defined, comprised of separate intervenular black dots; fringe a little darker than wing. **Hindwing** with a smoky



Figs. 23-28. Female genitalia of *Rostrolaetilia* spp.: 23, *R. placidella*; 24, *R. minimella*; 25, *R. placidissima*; 26, *R. utahensis*; 27, *R. coloradella*; 28, *R. cureka*.

tint; a thin, barely darker line at termen; fringe concolorous with wing. **Forewing** beneath yellowish brown, becoming dark gray at costa near apex. **Hindwing** beneath a little darker than above.

Wing expanse: 20.0 and 22.0 mm.

Female genitalia (Fig. 26): Very similar to those of *R. coloradella*; the main

difference is in the lamella postvaginalis, which is well sclerotized in *coloradella* and very poorly sclerotized in *utahensis*.

Holotype: Female, Richfield, Utah, June 15, 1930, caught in light trap; genitalia slide USNM 52,379; USNM Type No. 73,283.

Paratype: Female, Richfield, Utah, June 15, 1930, caught in light trap; Carl Heinrich Slide No. 1126.

***Rostrolaetilia coloradella* Blanchard & Ferguson, new species**

Figs. 5, 27

R. coloradella appears to be a small species, similar in appearance to *minimella* except that the subbasal spot at the inner margin is undeveloped, and the discocellular dot is single, not double. The following description is of the female only; the male is unknown.

Labial palps light smoky gray, paler beneath than above; **head, collar, thorax** and **tegulae** whitish with an ochreous tint; **forewings** white, sprinkled with blackish scales; antemedial line white, nearly straight, one-third length of wing from base, not distinct from background between costa and radius; a faint blackish dash at base, below which the lower half of basal space changes from ochreous basally to blackish at inner border of antemedial line; a square black spot adjoins antemedial line in medial space from radius to fold, resting on a squarish patch of ochreous scales extending to inner margin; distal limit of this patch not sharp: it continues, considerably paler, to postmedial band; postmedial band a wide, wavy white line between two narrow blackish lines, drawn in opposite discal dots and in fold; outer line well marked only near costa; inner line widest and most distinct opposite cell, not reaching costa; lower discal dot well marked, upper discal dot small or obsolete; fringe concolorous with background. **Hindwings** white with a faint smoky tint; a darker line at termen; fringe white.

Wing expanse: 15.5 mm.

Female genitalia (Fig. 27): Bursa copulatrix nearly spherical, diameter a little less than length of tergum of seventh segment; signum lateroventrally on right side of bursa; ductus bursae straight, well sclerotized to less than its diameter from ostium bursae where it is membranous; lamella antevaginalis crescent shaped, the points of the crescent fused with lamella postvaginalis; lamella postvaginalis with pointed "wings" bridging the gap in the collar and a "tail" directed toward ovipositor; dorsal, membranous pocket of collar wide; collar not infolded.

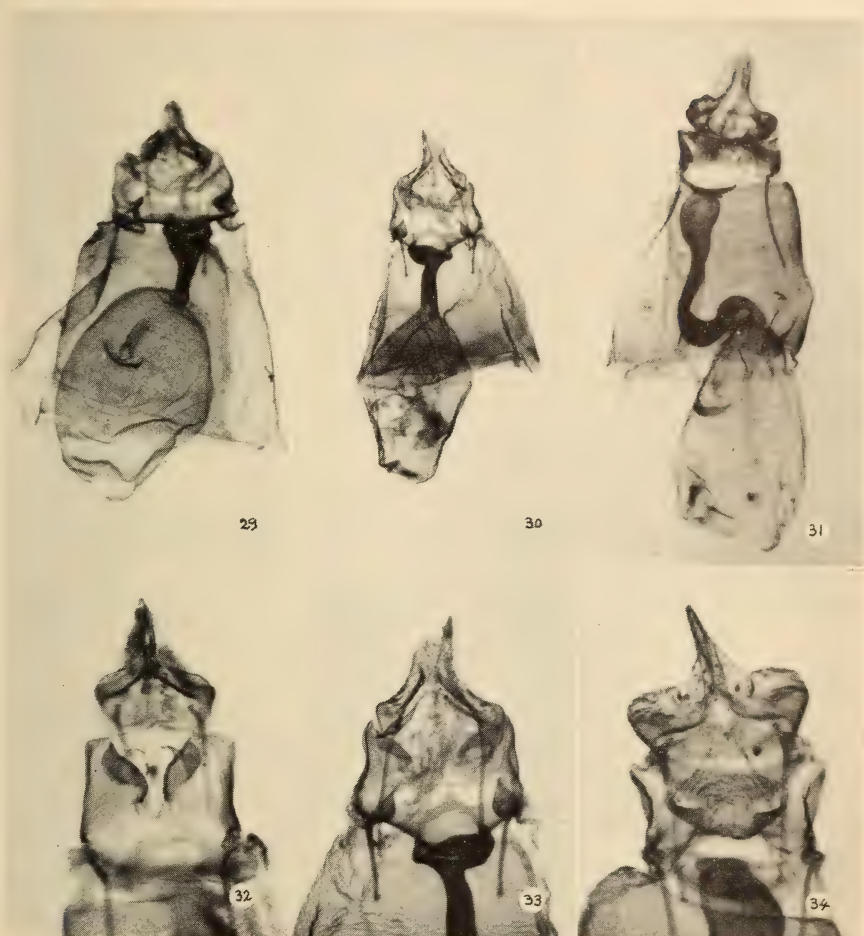
Holotype: Female, Pueblo, Colorado, July, from W. D. Kearfott collection, now in U. S. National Museum; genitalia slide USNM 52,374; USNM Type No. 73,284.

The holotype is the only specimen available for description.

***Rostrolaetilia eureka* Blanchard & Ferguson, new species**

Figs. 6, 18, 28

R. eureka is a moderately large, dark species that may be distinguished from all others except perhaps *pinalensis* by the presence on the forewing of a diffuse, dark, oblique streak running from the inner margin near the antemedial band to a point just before the apex. *R. nigromaculla* and to a lesser degree *ardiferella* and *texanella* have in the same position an oblique boundary between light and dark zones of the wing but no distinct streak.



Figs. 29–31. Female genitalia of *Rostrolaetilia* spp.: 29, *R. nigromaculella*; 30, *R. ardiferella*; 31, *R. texanella*. Figs. 32–34. Dorsal view of eighth segment of female abdomen showing membranous pocket in sclerotized collar: 32, *R. placidissima*, 33, *R. ardiferella*, and 34, *R. texanella*.

Labial palps brownish, clothed with white-tipped brown scales, lighter brown beneath; **front, vertex** and **collar** gray; **thorax** and **tegulae** smoky gray. **Forewing** above white, dusted with blackish scales in most of costal half and terminal space; a short, black basal dash; lower half of basal space mottled ochreous and blackish, more nearly ochreous at base, more nearly black along antemedial line; antemedial line white, lost in ground color above radius, outwardly bordered by a dark-brown, subtriangular spot extending from radius to fold; below this black spot an ochreous patch extending to inner margin; a smearing of ochreous and brownish scales appears as a continuation of this ochreous patch throughout lower half of median space; postmedial band a whitish line between two black lines; inner line diffuse in its

lower half, but heavy and projecting as a point between the discal dots, not quite reaching them; outer line starting from a triangular black spot at apex; lower discal dot well marked, upper one smaller; a short, dark dash longitudinally in cell, directed toward discal dots, not quite reaching them; to the naked eye a diffuse, dark shadow appears to prolong the black borders of the postmedial band diagonally to the ochreous patch at inner margin; terminal line smoky; fringe whitish, smoky at base and medially. **Hindwing** above smoky with faintly darker terminal line; fringe with its two rows of scales differing in color: short scales concolorous with wing, long scales perceptibly lighter. **Forewing** beneath smoky, a white patch at apex traversed by a blackish streak; fringe with colors arranged in zones; narrowly white at tip, narrowly smoky basad of the white and with several intermediate color zones. **Hindwing** beneath as above.

Wing expanse: Male, 16.0 and 18.5 mm; female, 16.0–18.0 mm.

Male genitalia (Fig. 18): Domelike part of uncus about half as wide as tegumen, its dorsal margin semi-circular, with semi-circular emargination between points of attachment to tegumen; ventral margin shortly produced with wide base and narrower apex, shaped as an inverted V; domelike part of gnathos barely wider than domelike part of uncus, resting on a wide bridge connecting it to tegumen; a deep, narrow, dorsal and a shallower ventral emargination of the domelike part of gnathos almost cut it in two; the two halves of gnathos curve gently into the inner tubular arms; transtilla plates small, subtriangular; juxta with well-sclerotized anterior margin; vinculum as wide as long with broadly rounded terminal margin; aedeagus short, without cornuti; valves simple, with widely rounded membranous part.

Female genitalia (Fig. 28): Corpus bursae about as long as tergum of seventh segment, a little more than half as wide; signum a sclerotized crescent located dorsally, at about mid-length; ductus seminalis from just caudad of signum; bursa tapering into thin ductus bursae that is slightly shorter than corpus bursae; ostium bursae half as wide as diameter of collar, flattened, membranous; lamella post-vaginalis well sclerotized, trapezoid, as long as collar, slightly narrower caudad than cephalad, filling a gap of same shape in collar; dorsal membranous pocket of collar as long as collar, about half as wide, between barely infolded ends of collar.

Holotype: Male, Eureka, Utah, 14 August 1911, Tom Spalding, collector; Carl Heinrich slide No. 1129; USNM Slide No. 52,473; USNM Type No. 73,285.

Paratypes: All same locality and collector—7 July 1911, 1 ♀; 20 July 1911, 1 ♀, 11 August 1911, 1 ♀; 14 August 1911, 1 ♂; 15 August 1911, 1 ♀, 16 August 1911, 1 ♀.

Rostrlaetilia nigromaculella (Hulst)

Figs. 8, 21, 29

Aurora nigromaculella Hulst, 1900 [1901]: 224; 1902 [1903]: 438.

Rindge, 1955: 167.

Zophodia nigromaculella, Dyar 1904a: 228.

Saluria nigromaculella, Hampson, 1918: 100.

The superficial appearance of this and the following two species, *ardiferella* and *texanella*, is so similar that it needs to be fully explained only for one of them. We choose to describe in detail *texanella*, for which a better, longer series is available. *Nigromaculella* is on the average smaller than *texanella* with somewhat broader wings; its ground

color is definitely more ochreous; the blackish shadow from apex to middle of inner margin is generally more obvious in *nigromaculella*.

Wing expanse: Male, 14.0–18.0 mm; female, 13.0–18.0 mm.

Male genitalia (Fig. 21): Anterior margin of uncus considerably produced in length and breadth, with narrow emargination between its points of attachment to tegumen; posterior margin developed as a thick, subtriangular process, covered with stiff setae, truncated at tip; posterior margin of gnathos deeply emarginate; no separation between dorsal dome of gnathos and its inner armlike processes: each half of dome curving gently into the tubular arms which are strongly mucronated at their tips; juxta with well-sclerotized anterior margin; vinculum short, broadly rounded; valves with strongly sclerotized, slightly convex costa; membranous part of valve slightly produced beyond distal end of costa and strongly sclerotized, bearing small teeth at base; aedeagus medium, slightly curved, vesica armed with several small cornuti.

Female genitalia (Fig. 29): Corpus bursae as long as tergum of seventh segment, its diameter about three-fourths its length; signum a lightly sclerotized crescent around origin of ductus seminalis, ventrally located slightly left of center; ductus bursae straight, half as long as corpus bursae, much thickened to within a fraction of its diameter from ostium bursae, where it abruptly becomes thinner; ostium bursae funnel shaped, sclerotized all around, almost as broad as collar, attached to the ends of the collar, much flattened anteroposteriorly; dorsal membranous pocket of collar wide, wrinkled, with angular, sclerotized caudal margin.

Holotype: Female, Santa Rita Mountains, Arizona, 8 June 1898, E. A. Schwarz, collector; Carl Heinrich slide No. 2269; USNM slide No. 52,476; USNM Type No. 5,185.

Other specimens examined: 3 ♂♂, 20 ♀♀, Baboquivari Mountains, Pima Co., Arizona, 1 May–15 June, 15–30 October 1924, O. C. Poling; 1 ♀, Madera Canyon, Santa Rita Mountains, Arizona, 27 August 1946, J. A. Comstock and L. Martin; 1 ♀, Redington, Arizona, no date; 1 ♀ (tentatively identified), Kingman, Arizona, 1–7 October; 1 ♀, Gran Quivira National Monument, Socorro Co., New Mexico, S. F. Wood.

Rostrolaetilia ardiferella (Hulst)

Figs. 7, 12, 19, 30, 33, 36, 38

Altoona ardiferella Hulst, 1888: 116; 1890: 208. Barnes and McDunnough, 1918: 176. Shaffer, 1968: 89.

Zophodia ardiferella: Ragonot, 1889: 116.

Tolima ardiferella: Ragonot, 1901: 506, pl. 24, fig. 14.

Saluria ardiferella: Hulst, 1902 [1903]: 439. Hampson, 1918: 99.

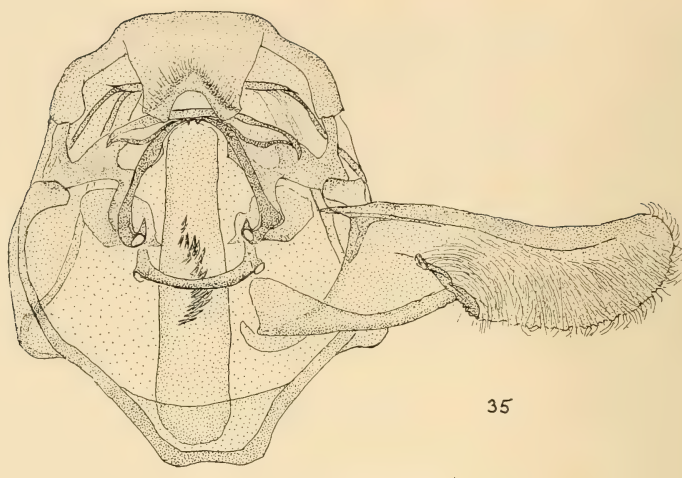
Pectinigera [sic] *ardiferella*: Dyar, 1904b: 159.

Pectinigera ardiferella: Barnes and McDunnough, 1917: 149. McDunnough, 1939: 35.

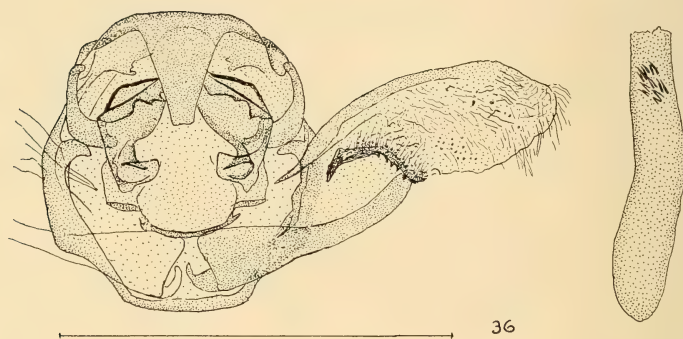
The superficial appearance provides no reliable means of distinguishing this species from *R. texanella* or *R. nigromaculella*. Most specimens are smaller than the smallest *R. texanella*, but some have a wing expanse which falls within the range for *R. texanella*.

Wing expanse: Male, 14.5–18.0 mm; female, 14.5–16.0 mm.

Male genitalia (Figs. 19, 36): Dorsal margin of uncus with wide, semicircular emargination; ventral margin developed in a long, flat, subtriangular process slightly



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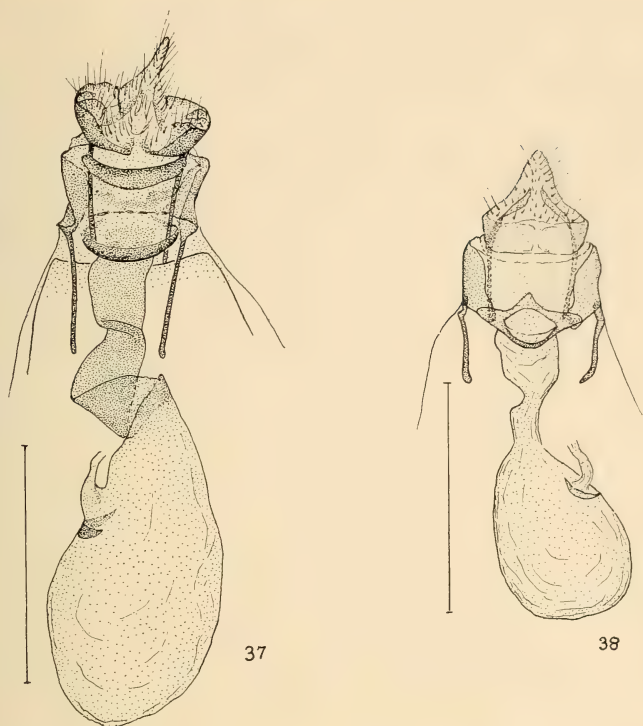


36

Figs. 35–36. Male genitalia of *Rostrolaetilia* spp.: 35, *R. texanella*, with aedeagus *in situ*; 36, *R. ardiferella*, with aedeagus removed.

truncated at tip; ventral margin of gnathos deeply emarginate; no definite separation between dorsal dome of gnathos and inner armlike processes: each half of dome curving gently into tubular arms which flare widely at their extremities, embracing aedeagus; just under dome of gnathos are two laminar, denticulate extensions; juxta with well-sclerotized anterior margin; vinculum short, broadly rounded; valves with strongly convex costa; base of membranous part of valves sclerotized and bearing several small teeth; aedeagus medium, slightly curved; vesica armed with three or four small cornuti.

Female genitalia (Figs. 30, 33, 38): Corpus bursae a little longer than tergum of seventh segment, two-thirds as wide as long; signum a lightly sclerotized crescent around origin of ductus seminalis; ductus bursae straight, much thickened to within a fraction of its diameter from ostium bursae, half as long as corpus bursae; ostium



Figs. 37-38. Female genitalia of *Rostrolaetilia* spp.: 37, *R. texanella*; 38, *R. ardiferella*. All figures within each group to same scale. (Illustrations by A. Blanchard.)

bursae sclerotized all around vaginal opening, with a small, pointed, caudal extension and two lateral, triangular extensions so long that collar is outfolded where they meet it; dorsal membranous pocket of collar wide, short, between incomplete infoldings of collar, with angular, slightly sclerotized caudal margin.

Holotype: Female, "Blanco Co., Cent., Texas", no date, from the Fernald Collection; Carl Heinrich slide No. 2270; USNM Slide No. 52,480; USNM Type No. 73,280.

Other specimens examined (all collected in Texas by A. and M. E. Blanchard): Paducah, Cottle Co., 17 April 1968, 1 ♂, 1 ♀; Shafter, Presidio Co., 18 October 1968, 1 ♂, 15 October 1969, 1 ♂, 16-19 October 1973, 2 ♂♂, 1 ♀; Artesia Wells, Chaparral Wildlife Management Area, La Salle Co., 10 November 1973, 2 ♂♂.

***Rostrolaetilia texanella* Blanchard & Ferguson, new species**

Figs. 9, 11, 14, 20, 31, 34, 35, 37

This species is extremely similar to *ardiferella* but averages larger. The genitalia are distinct.

Palps black above, varying beneath from white at base to blackish at apex; **head**, **collar**, **thorax** and **tegulae** gray; **forewing** above white in most of costal half, sprinkled with black scales increasingly from base to postmedial band; costa black at extreme base; antemedial line not distinct between costa and radius, where it blends into ground color; a short, blackish, diffuse basal dash; a black spot, variable in shape, usually squarish, adjoining outer border of antemedial line between radius and fold; a patch of mottled ochreous and blackish scales filling lower half of basal space below basal dash, is interrupted by antemedial line, but continues beyond it toward postmedial band between black spot and inner margin; color most nearly ochreous immediately below black spot; postmedial band a whitish line between two black borders, arising from an oblique, triangular black patch at costa, slightly drawn in opposite cell and in fold; a variable blackish shadow, obvious in some specimens, almost absent in others, diagonally through median space from costal black patch near apex to middle of inner margin; two discal dots, lower one generally a little larger; many specimens show a thin black streak running longitudinally through cell, usually ending between discal dots; an incomplete, poorly defined black terminal line; fringe gray at base and outer edge, white between. **Hindwing** white with a smoky tinge, especially along termen and at apex; fringe concolorous with wing. **Forewing** beneath largely grayish brown. **Hindwing** beneath, as above.

Wing expanse: Male, 16.0–22.0 mm; female, 18.0–22.0 mm.

Male genitalia (Figs. 14, 20, 35): Ventral margin of uncus produced in a trapezoid extension, covered with bristles, with wide base and narrower apex that is shaped like an inverted U; gnathos as wide as uncus and nearly flat; inner armlike processes of gnathos fuse medially, each one connected by two laminar extensions to near point where gnathos is attached to tegumen; armlike processes themselves curve in a semicircle on each side of aedeagus and exceed caudal margin of juxta; transtilla plates large, dorsad of armlike processes; anterior margin of juxta well sclerotized; valves simple, narrowest at distal extremity of sacculus; vinculum subtriangular with truncated terminal margin; aedeagus long, thin; vesica armed with numerous small cornuti.

Female genitalia (Figs. 31, 34, 37): Bursa copulatrix a little longer than tergum of seventh segment, about half as wide as long; signum a transverse crescent on left side at about mid-length; ductus seminalis from just caudad of signum; ductus bursae sclerotized, contorted, a little longer than corpus bursae, constricted at junction with ostium bursae; lamella antevaginalis a narrow, sclerotized, crescent-shaped lip; trapezoid lamella postvaginalis filling a gap in collar, twice as broad at its posterior as at its anterior margin; dorsal membranous pocket of collar deep, broad, wrinkled, limited laterally by incompletely infolded collar.

Holotype: Male, Mt. Locke, Davis Mountains, Jeff Davis Co., Texas, 4 July 1969, A. and M. E. Blanchard; genitalia on slide A.B. 1800; USNM Type No. 73,286.

Paratypes: Two specimens in U. S. National Museum labelled Chiricahua Mts., Arizona [no date], 1 ♀, and So. Arizona, August 1–15, 1 ♀. Forty-three specimens collected in Texas by A. and M. E. Blanchard, as follows: Fort Davis, Jeff Davis Co., 13 October 1966, 3 ♂♂; 24 August 1967, 1 ♂; 23 October 1973, 1 ♂; Mt. Locke, Davis Mountains, 6 September 1969, 1 ♂; 21 March 1971, 1 ♂; 19 July 1971, 1 ♂; 21 October 1973, 2 ♂♂; Sierra Diablo Wildlife Management Area, Culberson Co., 7 June 1969, 1 ♂; 31 August 1970, 1 ♂, 1 ♀; 29, 30 May 1973, 14 ♂♂; Green Gulch, Big Bend National Park, 9 October 1969, 2 ♂♂; 28, 31 March 1971, 3 ♂♂; Oak Spring, Big Bend National Park, 8 May 1972, 5 ♂♂, 5 ♀♀; Bear Canyon, Guadalupe Mountains National Park, 4 September, 1969, 1 ♂.

***Rostrolaetilia pinalensis* Blanchard & Ferguson, new species**

Figs. 10, 22

The following description refers to the male holotype only; no other examples are known.

Several unusual features distinguish this species. A relatively obvious oblique boundary between light and dark zones of the forewing runs from the middle of the inner margin toward the apex, the usual sub-basal dark spots are so modified as to be unapparent, and the lower discocellular dot has the appearance of being elongated as a thin streak parallel to the inner margin.

Labial and maxillary palps blackish above; **labial palps** whitish beneath; **front, vertex, collar, thorax and tegulae** concolorous gray; **forewing** above bears only white and dark brown to blackish scales; their proportion produces all the variations from whitish to brown and blackish; sprinkling of blackish scales lightest along costa and in terminal space, heavy in lower basal space where it forms a short, blackish dash and a small spot adnate to antemedial line along inner margin, heaviest in a bow-shaped fascia starting in cell just beyond antemedial line, outwardly directed below cubitus, smoothly turning in direction of apex, but ending on lower discal dot; upper discal dot weaker; a longitudinal black streak in cell, most intense basad of discal spots, thinning out before reaching antemedial line; beyond lower part of antemedial line a squarish, dark, faintly ochreous patch; postmedial band a white line between two gray lines, only slightly darker near costa, drawn in at fold; terminal line gray; fringe white basally, gray distally. **Hindwing** above glossy white. **Forewing** beneath brown, except near whitish apex; fringe concolorous with whitish median line. **Hindwing** beneath white.

Wing expanse: Male, 15.0 mm.

Male genitalia (Fig. 22): Ventral margin of uncus supporting a long process with parallel edges, bicuspidate at its extremity; ventral margin of gnathos deeply, widely emarginate; armlike processes of gnathos directed ventrally, embracing aedeagus with their spatulate extremities; transtilla plates large, appearing fused laterally to juxta, forming an almost continuous anellus; valves simple; vinculum a little longer than wide; narrowing to rounded terminal margin; aedeagus about as long as costa of valves; vesica armed with numerous minute cornuti.

Holotype: Male, Pinal Mountains, Arizona, elevation 5,000 feet, 15-30 April 1925, O. C. Poling, collector; USNM Slide No. 52,445; USNM Type No. 73,287.

Although the distinctive maculation of the unique type sets it apart from other known species of *Rostrolaetilia*, the characters of the male genitalia leave no doubt that it is rightfully placed in this genus.

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LYCAEIDES MELISSA (LYCAENIDAE) IN TEXAS: CONFIRMATION OF AN OLD RECORD

On 14 July 1974, the authors took a good series of adult *Lycaeides melissa melissa* (Edwards) at two locations in the Texas Panhandle. The locations were a dry creek bed at Estelline, Hall Co., and a gully along Texas Hwy. 207 just north of Tule Canyon, Briscoe Co. Adults were closely associated at both locations with *Glycyrrhiza lepidota* Pursh. (Leguminosae), and a female was observed to oviposit upon this plant. This plant is recorded as a larval foodplant for the species in Emmel and Emmel (1973, *The Butterflies of Southern California*. Los Angeles). No attempt was made at this time to collect ova or search for larvae. It was at first thought that the captures represented a new state record. However, the authors subsequently learned from Roy O. Kendall that a specimen of *melissa* had been taken in Tule Canyon in June 1876 (!) by Lt. Thomas M. Woodruff (Strecker, 1877, *Annual Report upon Explorations and Surveys in the Department of the Missouri*, Appendix: R R Annual Report Chief of Engineers for 1877. Washington, D. C.). It is probable that records for the intervening years will come to light.

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TWO NEW SUBSPECIES OF *PLEBEJUS* (*PLEBEJIDES*) *PYLAON*
FROM THE SOUTHERN AND NORTHERN SIDES OF THE
WEST CAUCASUS (*LYCAENIDAE*)

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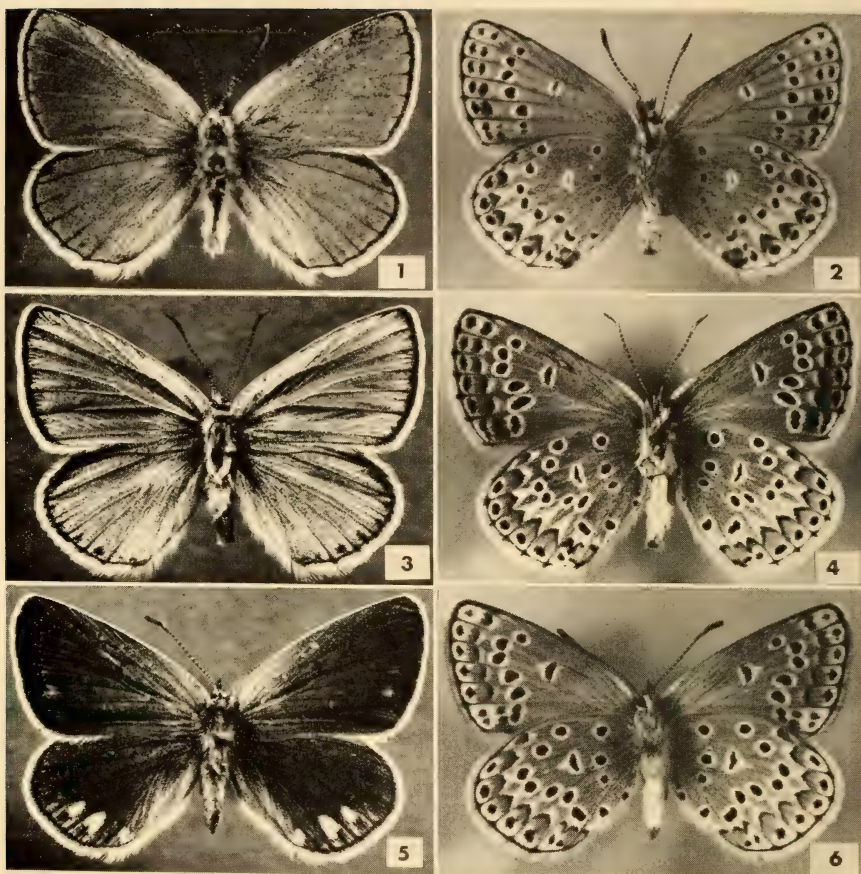
This is the sixth article in a series 'Rhopalocera Caucasica' (preceded by Nekrutenko, 1972; 1973; 1974a, b; 1975) dealing with the verification and precise determination of taxonomic positions of butterfly forms known to occur in the Caucasus area. A close examination of specimens of *Plebejus* (*Plebejides*) *pylaon* Fischer von Waldheim (1832: p. 357, tab. 19, figs. 5-6) collected on the southern side of the West Caucasus (Lake Ritsa) by Dr. Eugene S. Miljanowski and the author, and their comparison with a sample collected on the northern side (Teberda) by the late L. Sheljuzhko in 1933 (in the Zoological Museum, Kiev State University) showed that they represent different populations, distinct from all other geographic forms of the species hitherto described. They are herein described as new. In the descriptions I utilized Miller's (1969) veins and cells terminology.

***Plebejus* (*Plebejides*) *pylaon abchasicus* Nekrutenko, new subspecies**
(Figs. 1, 2, 7-9)

Lycaena escheri Hb.: Miljanowski, 1971, p. 138 (incorrectly identified).

Male. Length of the forewing (base-tip) of the holotype 15.3 mm (variation in type series 14.5-16.7 mm). Upper side of wings of clear blue-violet color, with slight metallic tint (as in ssp. *trappi* Vty of Switzerland, but somewhat duller). Veins easily recognizable only in their distal parts, where they are marked with dark scales, except R_s and M_1 of hind wing entirely marked with dark scales. Along outer margin of both wings is a very narrow black line, darker than inner row of fringe scales. Hindwing bears 1-5 poorly expressed antemarginal spots, in most specimens examined absent. Fringe pure white, with dark brown basal line, differing by its color from the marginal line of wing. Underside ground color warm brown, so pale that white rings around the black spots seem to disappear (visible on photographs). Described subspecies is the palest form of *pylaon* ever seen. Yellow submarginal spots presented on hind wing by a complete row, *never confluent*. Basally each spot is limited with a black V-shaped mark; on forewing, the number of these spots never exceeds 2-3, they are diffused, basally transit into black shapeless spots. Antemarginal spots on hind wing presented by complete row, some of them with blue metallic pupils, especially those corresponding with antemarginal spots on upper side (differing from *sephirus* Friv. of Bulgaria). Basal part of hindwing underside of light bluish color with metallic tint. No spot in the forewing (underside) discal (D) cell.

Male genitalia (Figs. 7-9). By general appearance do not differ essentially from



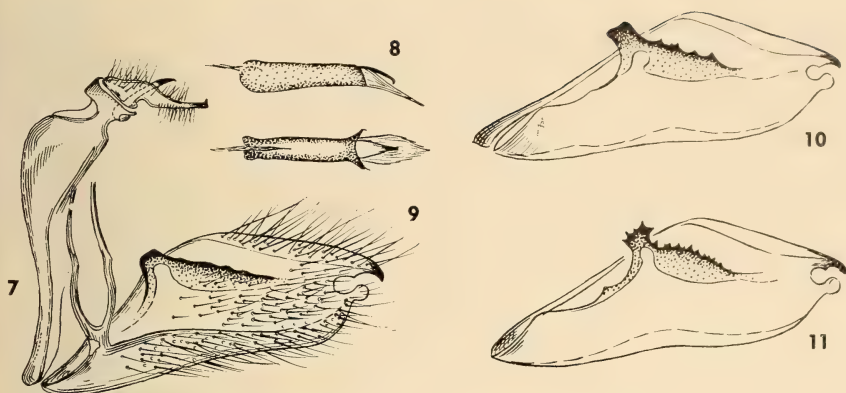
Figs. 1-2. *Plebejus (Plebejides) pylaon abchasicus* n. ssp.: 1, 2, ♂ holotype upper and underside, SW Caucasus, Lake Ritsa vic., 500-800 m, 6 June 1971.

Figs. 3-6. *Plebejus (Plebejides) pylaon albertii* n. ssp.: 3,4, ♂ holotype upper and underside, NW Caucasus, Teberda, Dzhmagat River Valley, 1200-1300 m, 28 July 1933 (L. Sheljuzhko leg.); 5,6, ♀ paratype, NW Caucasus, Teberda, Dzhmagat River Valley, 1200-1300 m, 25 July 1933 (L. Sheljuzhko leg.). All specimens figured are in the Lepidoptera Collection, Zoological Museum, Kiev State University.

other subspecies of *P. (P.) pylaon*. It is distinct with its smooth, rounded shape of the projection on the inner side of the valva ("Chitinleiste" of Forster (1938) and Sauter (1968)).

Female. Unknown, though we visited type locality many times in search for it; an additional description will be given if a female is collected.

Types. Holotype, male, SW Caucasus, Abkhassian Autonomous Soviet Socialist Republic, Lake Ritsa vicinity, 500-800 m, 6 June 1971, Y. Nekrutenko. Paratypes, 18 ♂♂, same locality, date and collector; 1 ♂ paratype, 15 July 1972, same locality and collector; 13 ♂♂ paratypes, same locality, June, July (? year) (coll.



Figs. 7-11. *Plebejus (Plebejides) pylaon* ssp. male genitalia: 7, *P. (P.) pylaon abchasicus* n. ssp., general view, right valva and aedeagus removed; 8, 9, *P. (P.) pylaon abchasicus* n. ssp., aedeagus, lateral and dorsal view; 10, *P. (P.) pylaon alburtii* n. ssp., valva, inner side; 11, *P. (P.) pylaon ordubadi*, valva, inner side.

E. Miljanowski, 1 ♂ paratype, Gagra circ., 1 July 1949 (coll. E. Miljanowski). Holotype and 5 paratypes ex coll. Y. Nekrutenko will be deposited in the Zoological Museum, Kiev State University.

Type locality. An old, abandoned timber-tracking road at its junction with the Bzyb-Lake Ritsa Highway (34th km), 5 km down along the Yupshara River from Lake Ritsa; small streams, emerging from the neighbouring rocks, flow as a thin water layer over the road chip-cover, attracting on a hot day great numbers of butterflies. Type locality situated within the mixed forest characterized by *Pinus hamata* Sosn. at an elevation of 500-800 m.

***Plebejus (Plebejides) pylaon alburtii* Nekrutenko, new subspecies**

(Figs. 3-6, 10)

Lycaena pylaon ssp.: Forster, 1938, p. 335, Taf. I-II, fig. d1.

Male. Length of forewing (base-tip) of the holotype 16.6 mm (variation in the type series 14.8-17.5 mm). Upper side of wings of blue-violet shining color, similar to *abchasicus* described above. Black marginal line varies in width, always notably wider than in *abchasicus*, in some specimens 1.0-1.5 mm wide. Antemarginal hindwing upper side spots developed well, in some specimens joining the marginal line, forming the wide marginal band; in others antemarginal spots shaded from basal side with dull brown (never in *abchasicus*). Under side ground color grey-brown, white rings around the black spots fairly visible. Yellow submarginal underside spots presented by complete row, in most specimens examined confluent (never in *abchasicus*), forming the continuous band, limited basally with a complete row of V-shaped black marks. Basally these black marks sharply contact bright white patches, contrasting with the ground color. Basal part of the hindwing underside of light blue color.

Male genitalia (Fig. 10). Projection of the inner surface of valva rounded in its proximal part, its ridge bears sharp incisions and projections (absent in *abchasicus*, more developed and presented on the proximal part too in *ordubadi* Forst. (Fig. 11)).

Female. Length of the forewing (base-tip) 14.0–14.5 mm. Upper side dark brown, with more recognizable dark discal spot. Hindwing upper side bears 3–4 dull yellow spots with diffused ground color pupils, distally rounded with violet tint. Basal part of hindwing under side powdered with scarce violet scales. Under-side ground color pale brown-grey, more vivid than in male. Underside pattern as in male, developed stronger and more contrast. Blue basal area very narrow. No spot in D in male and female.

Types. Holotype, male, NW Caucasus, Karachayevo-Cherkessian Autonomous Region, Teberda, Dzhamagat River Valley, 1200–1300 m, 28 July 1933, L. Sheljuzhko. 35 ♂♂, 3 ♀♀ paratypes, same locality and collector, 24 July–1 August 1933; 3 ♂♂, 1 ♀ paratype, Teberda, Mt. Chatipara, 4–7 August 1933; 4 ♂♂ paratypes, Teberda, Teberda River Valley, 22 July 1933; 2 ♂♂ paratypes, Elbrus Mt., Itkol, 24 June 1934 (A. Moltrecht leg.); 1 ♂ paratype, Elbrus Mt., Tegenekli, 25 June 1934 (A. Moltrecht leg.). Type material is the property of the Zoological Museum, Kiev State University.

Type locality. Vicinity of the town Teberda, Teberda Nature Reservation (Teberdinskiy Zapovednik) at an elevation of 1200–1400 m.

It is a pleasure to name this subspecies after Dr. B. Alberti of Göttingen (West Germany) in order to acknowledge his important contribution to the knowledge of the Lepidoptera of Caucasus.

Remarks

The geographic variation of *P. (P.) pylaon* (type locality: Sarepta, now Krasnoarmeisk, on Volga—see important data in Sheldon, 1914: 233–242, 273) has been studied in detail in western Europe, from where several subspecies have been described (Forster, 1938; Agenjo, 1967; Junge, 1971; Gómez-Bustillo & Fernández-Rubio, 1972). At the same time, the eastern and, especially, the northeastern part of the species range, including Caucasus and Transcaucasia, in much degree still remains a *terra incognita*, mainly because of the lack of reliable material. *P. (P.) pylaon abchasicus* ssp. nov. and *P. (P.) pylaon albertii* ssp. nov. are the very first geographic forms, representing two populations isolated by the Main Caucasus Ridge (Caucasioni), described from the Caucasus Major. The statement of “Elbrus” for ssp. *solimana* Forst. by Beuret (1961: 341) is a result of confusion with Elbrus in Iran. From Transcaucasia and adjoining areas, the following forms of the species are known: *ordubadi* Forster, *solimana* Forster, *iranica* Forster, *sephirus* Friv., *microsephyrus* Vty (for details see Forster, 1938).

ACKNOWLEDGMENTS

Appreciation is expressed to Miss Lydia M. Pisareva, Director, Zoological Museum of the Kiev State University for her kind help and understanding in the course of this study. Important suggestions incorporated in this paper were expressed by Dr. B. Alberti (Göttingen)

and Dr. Eugene S. Miljanowski (Sukhumi). My sincere thanks are due to Dr. George L. Godfrey for his kind editorial help.

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CLINAL INTERGRADATION OF *HESPERIA COMMA*
COLORADO (HESPERIIDAE)

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Hesperia colorado (Scudder) was treated as a separate species from *H. harpalus harpalus* (Edwards) and *H. harpalus ochracea* Lindsey (MacNeill, 1964). This paper demonstrates that *H. colorado* intergrades clinally with another subspecies of *H. harpalus* near *ochracea*. Since *H. colorado* has priority over *H. harpalus*, *harpalus* can no longer be used as the species name. Higgins and Riley (1970) and C. D. MacNeill (unpublished) now consider these American taxa to be subspecies of *Hesperia comma* (Linnaeus), therefore I will use the names *H. comma colorado* and *H. comma ochracea*.

The Arkansas River Valley in Lake and Chaffee Counties, Colorado, was chosen for study because its gradual descent towards the plains provided a relatively even environmental gradient allowing intergradation of *H. comma*, which evidently is continuously distributed along the river. Six stations were chosen at about equal distances along the river (Table 1).

The population of *H. comma* from Salida to Cotopaxi, referred to below as *H. c. ssp.*, represents an undescribed subspecies differing from *H. c. ochracea* in having a more yellowish ochre-yellow ventral ground color, and in having the ventral hindwing spots silvery white and forming an acute chevron as in *H. c. colorado*, whereas *H. c. ochracea* often has this band differently shaped and often ochre-suffused.

Results

Wing pattern. *H. c. colorado* is darker than *H. c. ssp.* in ground color and darkness of the ventral front wing tornus. Fig. 1 shows the specimens used as color grades from light to dark. Table 1 demonstrates the cline of ventral hind wing color from mostly black overlain with greenish ochre scales in *H. c. colorado*, to mostly yellow in *H. c. ssp.*

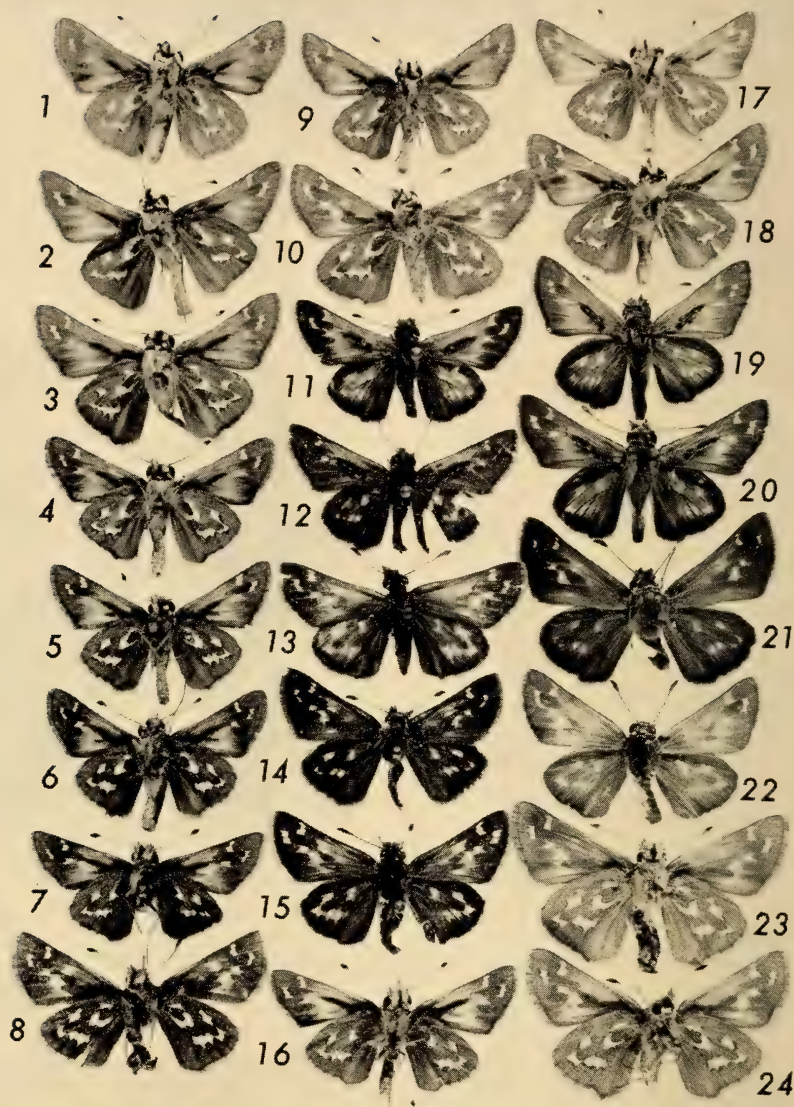
There is considerable variation in *H. c. colorado*, much more than in *H. c. ssp.* The dorsal ground color of *colorado* varies from light to dark. The ventral forewing tornus varies from nearly solid black to ochre (darker in females). The dorsal forewing apical spots are usually reddish brown but are rarely whitish in males and occasionally whitish in females. The ventral hindwing is rarely green in males, and occasionally green in females, but usually has yellowish ochre scales of variable

TABLE 1. Number of specimens per color grade and average color grade for each locality. Mileage refers to the distance downstream along the Arkansas River from the Tennessee Pass locality.

Mileage and Locality	Sex	Number of Specimens Per Color Grade								Average Color Grade
		Color Grade								
		1	2	3	4	5	6	7	8	
0 mi., near Tennessee Pass, 10400'	♂	—	—	4	8	13	18	4	—	5.21
	♀	—	—	—	3	12	6	3	1	5.48
0 mi., near Tennessee Pass (reared)	♂	—	—	3	1	—	—	—	—	3.25
	♀	—	—	1	3	3	—	—	—	4.29
14 mi., Mt. Massive Trout Club, 9400'	♂	—	2	5	16	8	1	—	—	4.03
22 mi., 1.6 mi. N. of Granite, 9100'	♂	—	2	10	8	2	2	—	—	3.67
	♀	—	—	—	—	1	—	—	—	5.00
28 mi., near Pine Creek, 8800'	♂	—	2	1	—	1	—	—	—	3.00
	♀	—	—	—	1	—	—	—	—	4.00
39 mi., near Buena Vista, 8500–9200'	♂	—	2	—	1	3	—	—	—	3.83
61–84 mi., Salida to Cotopaxi, 6600–7200'	♂	6	23	12	1	—	—	—	—	2.19
	♀	—	1	3	2	1	—	—	—	3.43

darkness over a black ground color. Rarely the underside is somewhat mottled. The ventral hindwing band is an acute chevron in most males but in only about a third of the females. One female had this band with scattered black scales. The ventral hindwing fringe sometimes has darker spots at the ends of veins. Variation of *H. c. ssp.* is similar except that ground color and ventral hindwing color is less variable, and the silver chevron is sometimes less silvery white than in *colorado*.

At least part of the darkness of *H. c. colorado* is genetic, because the



Figs. 1-24. *H. comma* adults. Figs. 1-8 have the underside color referred to in Table 1 using those same numbers. *H. c. colorado*: 5-7 ♂, 8 ♀, 9 ♂, 10 ♀, 11-12, ♂, 13-15 ♀, all near Tennessee Pass, 9-28 August. *H. c. ssp.*: 1 ♂ (6 mi. W Villa Grove, Saguache Co., Colorado, 9 August 1969); 3 ♂ (Spring Creek, Fremont Co., Colorado, 15 August 1965); 19 ♂ (3 mi. SW Cotopaxi, Fremont Co., Colorado, 3 August 1965); 20 ♂ (Querida, Custer Co., Colorado, 1 September 1962); 21 ♀ (Spring Creek, Fremont Co., Colorado, 7 August 1969); 22 ♀ (Silver

TABLE 2. Number of antennal shaft segments of males.

Number of Segments	Number of Specimens at each Locality					
	Tennessee Pass	Mt. Massive Trout Club	Granite	Pine Creek	E. Buena Vista	Salida to Cotopaxi
16	5	4	1	1	—	—
17	4	4	7	2	4	2
18	1	—	2	1	2	5

ventral ground color remained greenish on a black background in 4 males and 7 females which were reared indoors at about 20°C. The reared individuals were slightly larger, had greener ventral color (few wild individuals have green scales), and the upperside was somewhat lighter, than wild-caught *colorado*.

Genitalia. There are slight genitalic differences between *H. c. colorado* and *H. c. ssp.* In males the uncus is usually narrow in *H. c. colorado*, and is occasionally narrow but often broader in *H. c. ssp.* This character is also clinal. MacNeill (1964) stated that the penis of *H. c. colorado* had a unidentate rostellum, but I found that about 10% of both subspecies have a unidentate (versus a bidentate) rostellum. The female lamella postvaginalis is so variable individually that I cannot detect interpopulational differences; it is certainly no broader in *H. c. colorado*, and is sometimes narrower than in *H. c. ssp.*

Antennae. Antennal shafts are longer in *H. c. ssp.* (and *H. c. ochracea*) than in *H. c. colorado*, but this character is also clinal at least for males (Table 2). The 4 reared *colorado* males all had 16 segments, so this low number may be genetically inherited. The female antenna has a white ring at the base of the club in 80–90% of *H. c. ssp.* but only in 50% of *H. c. colorado* (16 of 32). The 2 females from Pine Creek and near Granite have almost a complete ring.

Early stages. *H. c. colorado* has fewer micropyle spines than *H. c. ochracea*. In *colorado*, 4 eggs had 4 spines, and 4 had 5 spines. In *ochracea*, 3 had 4 spines, 9 had 5 spines, and 5 had 6 spines. The larvae and pupae of both are almost identical to each other (Scott, 1974) and to *H. c. harpalus* (MacNeill, 1964). The laboratory developmental pe-

←

Park, Custer Co., Colorado, 1 September 1962); 23 ♀ (Kuntz Gulch, Fremont Co., Colorado, 26 August 1971). Intergrades: 2 ♂ (2 mi. E Buena Vista, 17 August 1971); 4 ♂ (Mt. Massive Trout Club, 16 August 1971); 16 ♀, 17–18 ♂, 24 ♀ (N of Granite, 16 August 1971).

riod of *H. c. colorado* is much shorter than that of *H. c. ochracea*, apparently through genetic adaptation to high-altitude (Scott, 1975).

Foodplants. In the laboratory, *H. c. colorado* and *H. c. ochracea* larvae feed on many different grasses (Scott, 1975). In nature, *H. c. ochracea* 1 mi. N of Cheesman Reservoir, Jefferson Co., oviposits on many different plants: 3 eggs were found on *Arenaria fendleri* (Caryophyllaceae) plants without inflorescences (which resemble grass), 1 egg on *Bouteloua gracilis* leaf, 3 eggs on *Andropogon saccharoides* leaves, and 8 eggs on *Carex* sp. leaves. A female at Nighthawk, Douglas Co., laid 1 egg on *B. gracilis* leaf. These eggs were distinguished from other *Hesperia* by the basal flange. It is possible that *H. comma* oviposits on any plant resembling a grass, and it may even oviposit on plants of other forms, which were not searched thoroughly. Because of broad larval tolerance and random oviposition, it is unlikely that *H. c. ochracea* is restricted to one larval host.

Mate-locating behavior. *H. c. colorado* and *H. c. ssp.* have the same mate-locating system. Males perch throughout the day on stones and other ground objects, and dart out at passing objects in search of females. This behavior occurs mainly on hilltops, where most males were collected except near Tennessee Pass, where males perched on top of mine spoils and on top of prominent banks of roads, which were evidently substitutes for hilltops. Copulating pairs of *H. comma* were found at 1029 and 1159 hours, at Cripple Creek, Teller Co., and at 1300 hours (all 24-hour ST) north of Granite, Lake Co., all on hilltops.

Other characters. MacNeill (1964) lists *H. c. colorado* as having fewer apiculus segments, longer eyelashes, and paler prothoracic tibial spines. The number of apiculus segments proved too variable (one *H. c. ssp.* had only 1–2 segments apparent ventrally) to find interpopulational differences, and significant differences between *H. c. colorado* and *H. c. ssp.* were not found in the other two characters.

Discussion

This paper describes intergradation of *H. c. colorado* only with *H. c. ssp.*, but I believe *colorado* also intergrades with *H. c. ochracea* and *H. c. harpalus*. At higher elevations west of the continental divide, populations contain individuals resembling *colorado*, *harpalus*, and individuals intermediate in wing pattern. *H. c. ssp.* occurs along the Arkansas River southward and in the San Luis Valley, and it intergrades phenotypically with *H. c. colorado* in western Conejos Co. *H. c. ochracea* occurs in "typical" form (it is quite variable) along the foothills of the Front Range. At higher elevations in Teller, Park, Jefferson, and Boulder

Counties, individuals become darker and with the white ventral spots less ochre and more in an acute chevron, characteristics of *colorado*. A population at Cripple Creek, Teller Co., is mostly referable to *H. c. ssp.* but has some *H. c. ochracea* and some *H. c. colorado* admixture. The situation in the Front Range of Colorado is complicated by great variability. It is my opinion that the Colorado specimens of *H. comma* "*manitoba*" (MacNeill, 1964) are part of the Front Range *H. comma ochracea-colorado* populations, and that the name *manitoba* should be applied only to populations north of Colorado.

Summary

H. c. colorado intergrades clinally with a subspecies of *H. comma* near *ochracea* in several wing and structural characters. At least one of these characters and duration of developmental stages differ when the two taxa are reared in identical conditions; the high altitude *H. c. colorado* therefore apparently differs genetically from the lower altitude *H. c. near ochracea*.

ACKNOWLEDGMENT

I thank Dr. C. Don MacNeill for reviewing the manuscript.

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GENERAL NOTE

BOLORIA TODDI OR *BELLONA*? (NYMPHALIDAE)

The eastern North American *Boloria* that for years had gone under the name *bellona* Fabricius suffered a change of name some 40 years ago. Hemming (1933, Entomologist 66: 276) noted that two species had received the name *Papilio bellona* in 1775, one by Fabricius and one by Cramer. With no way at that time of establishing relative priority of the two names, Hemming gave precedence to *Papilio bellona* Cramer (1775, Uitl. Kapellen 1: 20, pl. 13 figs. E, F), a neotropical pierid, because it was described more fully than the *bellona* of Fabricius and was illustrated.

With the name *Papilio bellona* Fabricius (1775, Syst. Ent.: 517) thus reduced to the status of a junior homonym the species had to bear the next oldest name that had been applied to it, which was *toddi* Holland (1928, Ann. Carnegie Mus. 19: 45), originally given to a subspecies from Quebec. This left the more widespread southern subspecies, formerly *bellona*, without a valid name, and Hemming proposed for it the name *ammiralis*. The combination *Boloria toddi ammiralis* Hemming came into wide and universal use down to the present day.

In 1958, however, the International Commission published Opinion 516 (1958, Opin. Decl. Int. Comm. Zool. Nomencl. 19: 1-44) assigning for the first time a definite date of publication (17 April 1775) to Fabricius' *Systema Entomologiae* and ranking the five major works published in 1775 in serial order for purposes of priority. By this *Opinion* Fabricius' *Systema Entomologiae* ranks first (earliest in the year) and Cramer's *Uitlandische Kapellen* (*Papillons Exotiques*), vol. 1, pp. 1-132, ranks last, and all relevant Fabrician names take precedence over those of Cramer.

This action reverses the step taken by Hemming in 1933. It restores the name *bellona* Fabricius to use and thereby synonymizes the name *ammiralis* Hemming.

As a result the species must once again be known as *Boloria bellona* Fabricius, and the following revised entry in the check list of dos Passos (1964, Lepid. Soc., Mem. 1: 89) is needed:

BOLORIA (CLOSSIANA) Reuss, "1920" [1922]599. **bellona** (Fabricius), 1775a **b. bellona** (Fabricius), 1775

‡*myrina* (Martyn), 1797, *nec* Cramer "1779" [1777]

ammiralis (Hemming), 1933

etc.

b **b. toddi** (Holland), 1928c **b. jenistai** Stallings & Turner, "1946" [1947]

Although the information necessary for reaching this conclusion has been published since 1958, it appears to have been largely overlooked. Several authors recently have changed the name back to *bellona* (e.g., Bayer & Shenefelt 1971, Mid-Cont. Lepid. Series 2 (no. 27): 4; and other articles in this journal beginning in 1969), but so far as I am aware only once has an explanation been given (Kuehn & Masters 1972, *op. cit.* 4 (no. 59): 9), and that only a brief statement. Wider dissemination and a fuller explanation of the situation would seem desirable, so I have prepared this note.

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15213.

EARLY STAGES OF SEVEN COLORADO *HESPERIA* (HESPERIIDAE)

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This paper adds to the information about *Hesperia* early stages given by MacNeill (1964), whose terminology I use. Taxonomic changes indicated by these early stages are discussed. *Hesperia comma* (Linnaeus) is used as the species name for *H. harpalus ochracea* Lindsey and *H. colorado* (Scudder), and *H. leonardus* Harris is used as the species name for *H. pawnee* Dodge, because of recent taxonomic studies (C. D. MacNeil, in press; Scott, 1975). In addition, I report another obvious method of determining the sex of pupae.

General Characteristics

First instar. The ring pores and setae, especially of the ventral setae, are occasionally aberrant in size or setal position. Setae of head and around the anal prolegs are the same for all species (Figs. 2, 16). Head is unicolorous brown; body is whitish. In setal pattern, Tii is the same as Tiii. Ai and Aii are the same as Aviii except the spiracles are only half as wide; Aiii to Avi are the same as Aviii except the spiracles are like Aii, and there is no sublateral ring-pore, and the proleg has two lateral setae side by side. Aix is the same as Aviii except there is no spiracle, and there is only one lateral seta, situated just above and slightly behind the ring-pore.

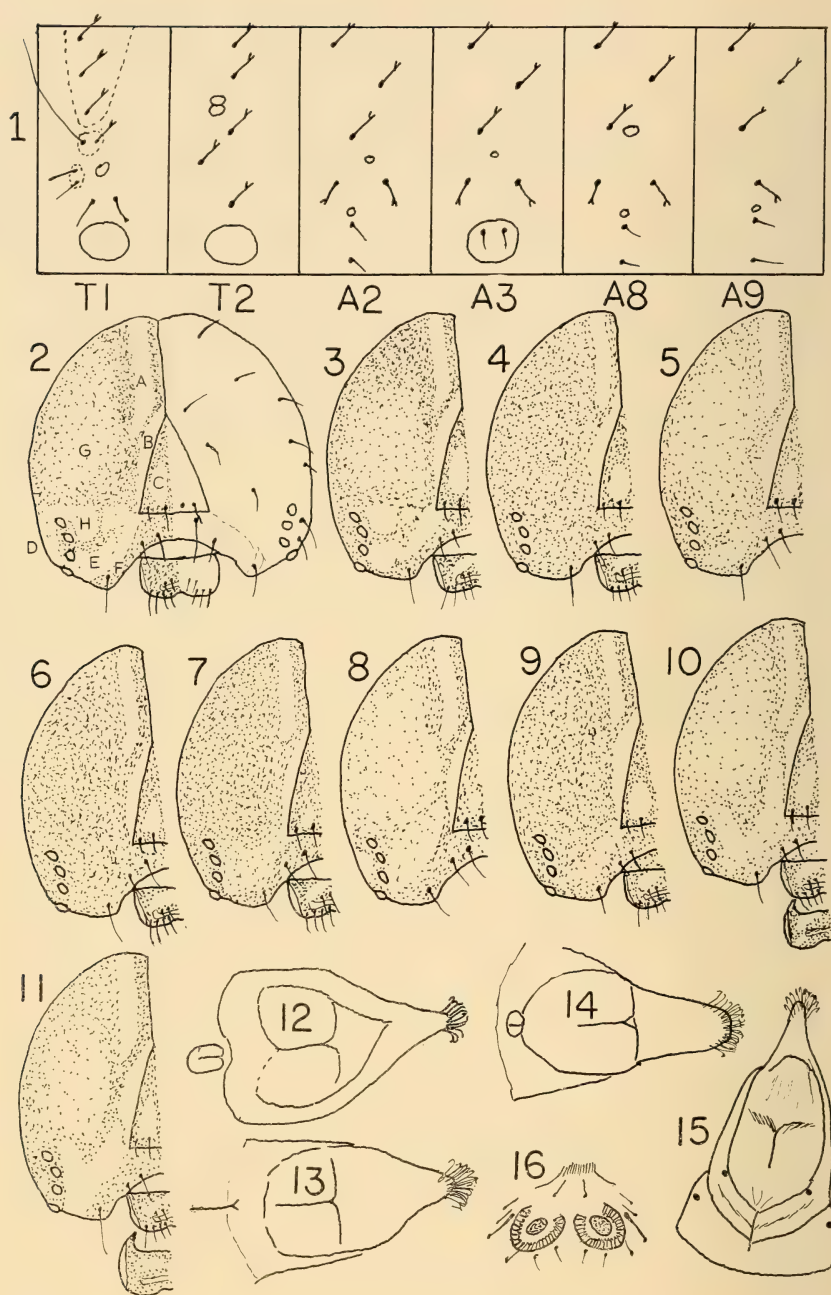
Mature larva. The head has light areas A, B, and C always present (Fig. 2). The body is dingy light brown, sometimes slightly maroon colored. Cranial punctures occur dorsad of a line just above the ocelli. The cranial setal pattern of all species is the same (Figs. 2-11), with a few large setae and many tiny ones. The labrum has 12 setae whereas only 10 occur in the first instar.

Pupa. The presence or absence, and size of, the dorsal ring pores is variable. Color is dingy light brown. The cremaster shape is somewhat variable. Black circular spots sometimes occur, especially ventrally. On dorsum and anterior of heads the setae are surrounded by pale areas (dark areas have no setae). Abdominal spiracles are functional on segments 2-7, and a non-functional pair occurs on segment 8. Brown spots mottle each segment of the abdomen; these spots are somewhat variable, and are similar between species. Cremaster hooks occur in an undivided cluster. Setae are simple, and incline anteriorly on head.

Just anterior to the cremaster is a small ventral groove (Figs. 12-15). In males of all species examined it is short and bounded by two hemispherical bumps; in females it is long and without bumps. This method of determining the sex of pupae also works in *Limenitis* (Kean & Platt, 1973) and *Phyciodes* (Nymphalidae). MacNeill (1964) showed that male pupae have the stigma visible on wing cases, and that males have slightly broader heads and bigger eyes than females.

Distinguishing Characteristics

H. viridis (Edwards) (1 mi. up Bear Creek, Chaffee Co., Colorado). First instar: sublateral ring pores as large as Ti spiracle. SD1 on Tii twice as long as other



Figs. 1-16. Larvae and pupae of *Hesperia* spp.: (1) setal map of first instar *H. leonardus montana* (from first thoracic (T) segment to ninth abdominal (A)

spatulate setae. Anterior and posterior suranal setae similar. AixD1 normal. Last instar: most heads fairly dark, often lighter at G and E. B has a light lateral protrusion at level of top of area C. Structural striations occur medial to upper ocelli in darker heads. Pupa: proboscis extends 2.5 mm beyond legs, $\frac{3}{4}$ of distance to cremaster base, slightly longer than *H. l. pawnee*. Cremaster narrow. Setae fine, short (0.1–0.2 mm), straight or slightly curved. Few ventral black spots occur.

H. uncas uncas Edwards (1 mi. up Bear Creek, Chaffee Co.). First instar: sublateral ring pores as large as Ti spiracle. SD1 on Tii normal. Anterior and posterior suranal setae alike. AixD1 normal. Last instar: very rarely D light, often a light triangular sickle-shaped light area at E, sometimes with G lighter, C rarely small. Structural striations occur mesad of upper ocelli on darker heads. Pupa: proboscis extends 1.3 mm beyond legs. Cremaster very broad, about 1.0 mm wide, with a greater number of hooks which are only slightly hooked (in other entities very hooked). Cluster of oval setae-bearing rings near proboscis wider, about 0.4 mm in diameter (0.3 in other entities). Dorsal and head setae longer, especially on abdomen, about 0.3–0.4 mm (only 0.1–0.2 mm in *comma*, *viridis*, and *pahaska* Leussler), wider, nearly straight. No or very few ventral black spots.

H. comma ochracea (1 mi. N of Cheesman Reservoir, Jefferson Co.). Egg: with ventral flange. Micropyle with 4–6 (usually 5) spines, 8–10 (usually 9) faint or absent rosette cells, spicules more common outside rosette. First instar: sublateral ring-pores as large as Ti spiracle. SD1 on Tii normal. Anterior suranal setae short and spatulate, same length as laterals. AixD1 normal. Last instar: pattern of head similar to *colorado*. Pupa: proboscis extends very slightly beyond legs. Cremaster narrow. Setae short (0.1–0.2 mm), wider, somewhat hooked on head. The ventral black spots are few.

H. comma colorado (near Tennessee Pass, Lake Co.). Egg: with ventral flange. Micropyle with 4–5 spines, about 9 cells in rosette, cells faint or absent, spicules entering rosette but more common outside. First instar same as *ochracea*. Last instar: head with G usually light, E and H light and separated by a dark patch narrowly connected to (rarely not connected) dark area around ocelli, D light. Pupa same as *ochracea*.

H. pahaska pahaska (Oak Creek, S of Canon City, Fremont Co., and 1 mi. up Bear Creek, Chaffee Co.). First instar: sublateral ring-pores less than $\frac{1}{2}$ diameter of Ti spiracle (ring-pore on Aii very small or absent). SD1 on Tii normal. Anterior and posterior suranal setae alike. AixD1 normal. Last instar: E sometimes light, F rarely light, C sometimes small, rarely a light spot at D. Heads darker than *l. pawnee* and *l. montana* (Skinner). Structural striations occur mesad of upper ocelli. Pupa: proboscis extends 3–4 mm beyond legs to base of cremaster, twice as long as in *H. l. pawnee*. Cremaster narrow (rarely 0.5 mm wide). Setae short (0.1–0.2 mm), fine, nearly straight. No or very few ventral black spots.

H. leonardus pawnee (Green Mountain, Jefferson Co.). Egg: without flange.

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segment; dotted lines border sclerotized areas; circles are legs, prolegs, spiracles, or ring pores). Head capsules: (2) light-dark pattern of mature larva (left half) illustrating eight potential light areas and setal pattern (right half) of first instar larva of *H. c. colorado*; (3) *H. c. ochracea*, mature larva; (4,5) *H. viridis*, mature larvae; (6) *H. uncas uncas*, mature larva and (7,8) third instar larvae; (9) *H. pahaska pahaska*, mature larva; (10) *H. l. pawnee*, mature larva; (11) *H. l. montana*, mature larva. Pupae: (12) ventral view of cremaster of male and (13) female of *H. l. montana*; (14) male of *H. uncas*; (15) female of *H. c. colorado*. Setal pattern (16) around anal prolegs of first instar *H. l. montana*.

Micropyle with about 7 spines, rosette of 8–10 cells very faint, usually absent, spicules abundant in rosette. First instar: sublateral ring-pores less than one-half diameter of Ti spiracle. SD1 on Tii normal. Anterior and posterior suranal setae alike. AixD1 normal. Last instar: G light, H and E combined in a V-shaped light area, E extending dorsally and almost meeting A, and a darker area between E and A, G light. Pupa: proboscis extends 1.0 mm beyond legs. Cremaster narrow. Setae slightly longer (0.2–0.3 mm), wider, nearly straight or slightly curved. Usually a rim posterior to "sex-mark." Black ventral spots common.

H. leonardus montana (Nighthawk, Douglas Co.). Egg: no flange. Micropyle with 7–8 spines, about 8–10 faint cells in rosette, spicules common in rosette. First instar: same as *pawnee*, except in 3 of 8 larvae there was a brown sclerite within crochets of anal proleg and a black anterior bar within crochets of other prolegs (absent in other entities). Last instar: same as *pawnee* but head slightly darker; D rarely a light spot, G darker, light only near dark spot where E and A come near each other. Pupa: same as *pawnee* except setae often narrower and black spots few.

Laboratory Developmental Rates

At least half the eggs of the only high altitude entity, *H. comma colorado* (10,400') had a laboratory diapause; and the larvae of this taxon developed faster than the other entities (6,000–7,000') which had no laboratory egg diapause and slower larval development. In *H. c. colorado* the period from oviposition to pupation took 50–59 days indoors in males, 56–63 days in females; the pupal stage lasted 14–15 days (occasionally 17) in males, 16–17 days in females. In the other entities, development from oviposition to pupation took 83–106 days (129 in one *H. c. ochracea*) in males, 102–114 (rarely 93) in females; the pupal stages lasted 22–29 days (rarely 36) in males, 19–30 in females. *H. c. colorado* apparently differs genetically from neighboring lower altitude populations because the developmental rates are shorter than for *H. c. ochracea* under identical laboratory conditions and wing pattern differences are maintained despite rearing in the laboratory.

Taxonomic Conclusions

The early stages generally support the conclusions of MacNeill (1964). The primitive condition of the first instar suranal plate seems to be with anterior resembling posterior setae. *H. l. pawnee* and *H. l. montana* are very similar, as are *H. c. ochracea* and *H. c. colorado*. *H. l. pawnee*, *H. l. montana*, and *H. p. pahaska* fit well into the *leonardus* group of MacNeill. *H. uncas*, however, may have to be removed from the *comma*-group, because the suranal anterior setae resemble posterior setae, the cremaster is peculiar, the first-instar sublateral ring-pores are larger than those of *H. juba* (Scudder) and *H. comma*, the pupal proboscis extends well beyond the legs, and the pupal oval-fields and dorsal setae

differ from those of *comma*. Altogether, *H. uncas* may resemble the ancestor of *Hesperia* more than *juba* or *comma*.

ACKNOWLEDGMENT

I thank Dr. C. Don MacNeill for reviewing the manuscript.

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LIFE HISTORY NOTES ON THREE TEXAS SPHINGIDAE

Manduca rustica (Fabricius). Hodges (1971, Fasc. 21, Sphingoidea, The Moths of America North of Mexico. London) gave this species as utilizing Verbenaceae and Boraginaceae as larval foodplants. Specific Texas larval foodplants in these families are *Lippia alba* (Mill.) N. E. Brown (Verbenaceae) and *Ehretia anacua* (Berl.) I. M. Johnson (Boraginaceae). On 16 October 1974, John B. Vernon found a larva on *L. alba* at Bentsen-Rio Grande Valley State Park. In the laboratory the larva readily accepted the closely related *Lantana camara* L. and was reared to an adult. At the same location, on 23 November 1974, Frank R. Hedges and Edward C. Knudson each found a larva of *rustica* on *E. anacua*. Determination was made by comparison with color photographs of the larva previously found. These larvae would not accept the *L. camara*; one died and the other was vacuum freeze-dried by Hedges.

Erinnyis ello (L.). Hodges gave only Euphorbiaceae as larval foodplants for this common species. On 16 October 1974, John B. Vernon and the author found larvae on *Bumelia angustifolia* Nutt. (Sapotaceae) at several locations in Hidalgo Co. Larvae were found in green, dark brown, and intermediate color forms, as described in Hodges. One larva of each color form was reared to adult stage, each producing a male.

Aellopos titan (Cramer). This species is occasionally common in the Lower Rio Grande Valley of Texas, and according to Hodges the larvae feed upon Rubiaceae. A specific Texas foodplant in this family is *Randia mitis* L. Frank R. Hedges observed a female ovipositing upon this plant near Mission, in Hidalgo Co., on 22 September 1974. Nine ova were collected. The larvae were reared by Hedges on another rubiaceous plant, *Cephalanthus occidentalis* L. (Common Buttonbush). As stated by Hodges, the larvae occurred in both green and brown color forms. One adult was reared from each color form, and the remainder of the larvae vacuum freeze-dried by Hedges in various instars.

ACKNOWLEDGMENT

I thank the Texas Parks and Wildlife Department for the issuance of collecting permits for Bentsen-Rio Grande Valley State Park.

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NOTES ON THE LIFE CYCLE AND NATURAL HISTORY OF
BUTTERFLIES OF EL SALVADOR. VI. *ANAEA* (*MEMPHIS*)
PITHYUSA (NYMPHALIDAE)

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It is evident in modern literature (e.g., Rydon, 1971; Comstock, 1961) that what little is known about the early stages of many Neotropical Charaxinae appears mostly in very old publications as descriptions with illustrations of varying quality. Unfortunately many of them are not much use to taxonomists. This paucity of life-history data has caused some confusion in the placing of genera within tribes and subtribes. My sons and I hope that our contribution will help the experts reach a consensus. We follow Comstock's (1961) nomenclature in this paper as in our previous five papers on the local Charaxinae.

Eggs and larvae of *Anaea* (*Memphis*) *pithyusa* R. Felder were first collected in 1967. These were reared in transparent plastic bags containing leaves of the foodplant, which were replaced every third day. Pupae were transferred to a box covered with mosquito netting until the adults emerged. The bags and box were kept in our insectary under ambient light and temperature conditions. Photographs were taken and records of measurements and time elapsed for each stage were kept. Specimens of the immature stages were preserved in alcohol and sent to the Allyn Museum of Entomology, Sarasota, Florida.

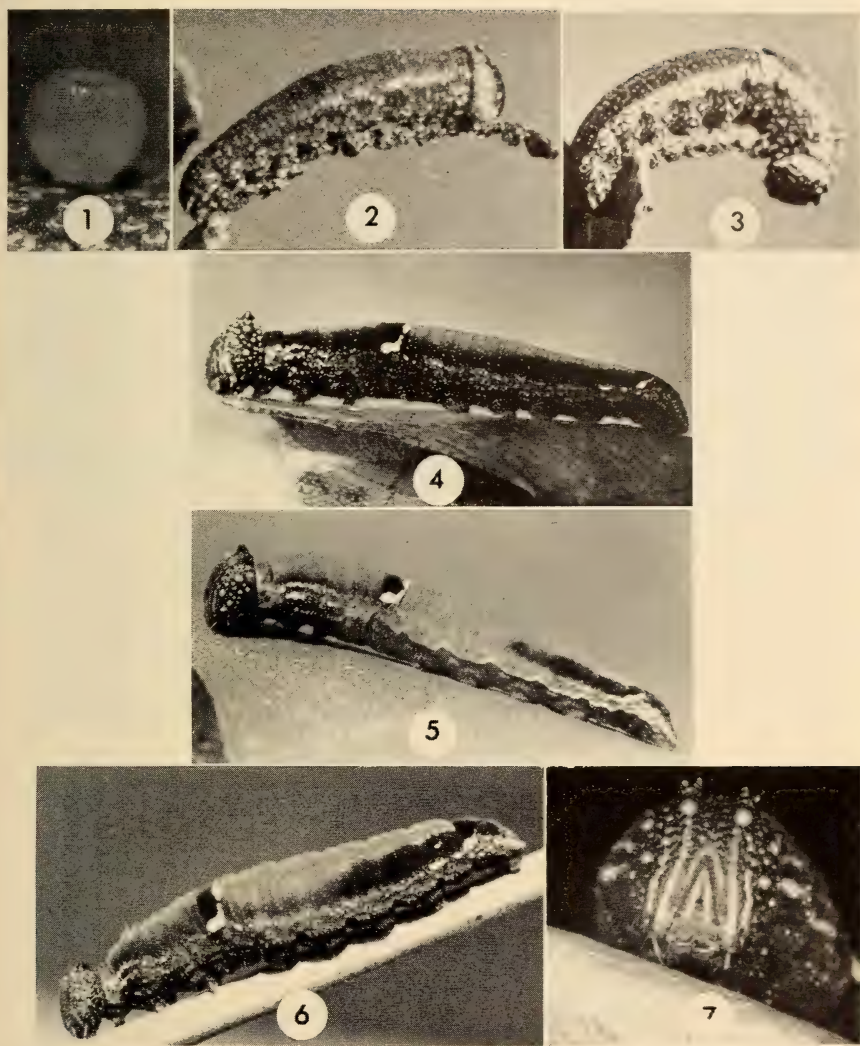
Life Cycle Stages

Egg (Fig. 1). Translucent light green, almost spherical with flattened base and depression at micropylar zone. No sculpturing visible under 10 \times magnification. Diameter about 1.0 mm. Hatch in 5 days.

First instar larva (Fig. 2). Head brown, hemispherical, naked, slightly thicker than body. Body greenish brown, naked, with annulets between segments. Body wedge-shaped on hatching, thickening around first abdominal segments after feeding. Measures 2.5 mm in length when recently hatched, growing to 5.0 mm before molting in 5-7 days.

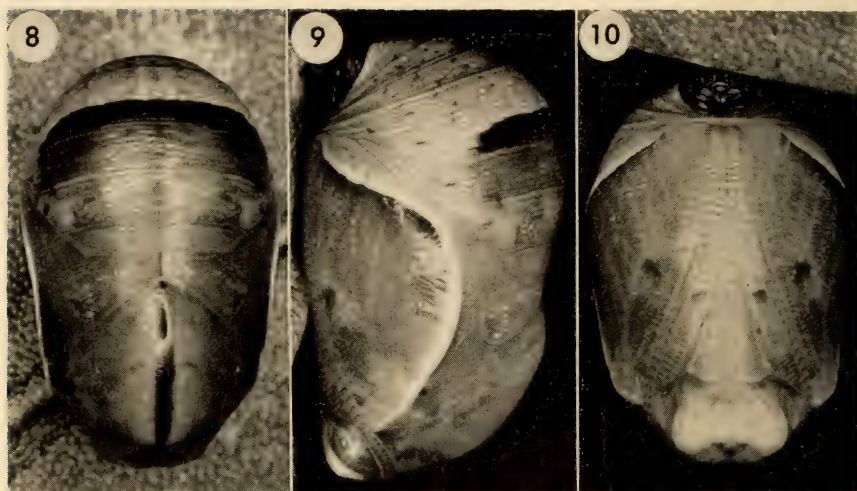
Second instar larva (Fig. 3). Head thicker than thoracic segments, brown with lighter tubercles and short black horns on epicranial apices. Body green or brownish green with faint black "saddle" across second abdominal segment. "Saddle" ends laterally by a whitish dot. Caudal segments with blackish tinge dorsally. Entire body spattered with tiny light brown spots. Grows to 7.0-9.0 mm in 3-5 days.

Third instar larva (Fig. 4). Groundcolor of head black with many yellowish tubercles, mostly around the stubby and knobbed black horns. Yellowish lines bordering frontal and adfrontal sutures, forming triangles, plus another two lines:



Figs. 1-7. *Anaea (Memphis) pithyusa*. 1, Egg, width about 1.0 mm; 2, first instar larva, length about 2.5 mm; 3, second instar larva, length about 4.0 mm; 4, third instar larva, length 15.0 mm; 5, fourth instar larva, length 26.0 mm; 6, fifth instar larva, 40.0 mm; 7, fifth instar larva, head, frontal view.

one descending from base of horns to side of mandible and a second line, shorter and parallel to the first, ending at antennal base. Body green or brownish green with many lighter spots, and a dark brown or blackish zone, variable in size, along subdorsal area of thoracic segments. Black "saddle" across second abdominal segment lined posteriorly by a white streak. Caudal segments show a variable black zone similar to second instar. First and second abdominal segments thicker than



Figs. 8-10. *Anaea (Memphis) pithyusa*. Pupa: 8, dorsal view; 9, lateral view; 10, ventral view.

the rest, body tapering caudad. Spiracles black, prothoracic much larger than the others; those on the second and eighth abdominal segments being slightly higher than the rest. Grows to 15.0-17.0 mm in 4-6 days.

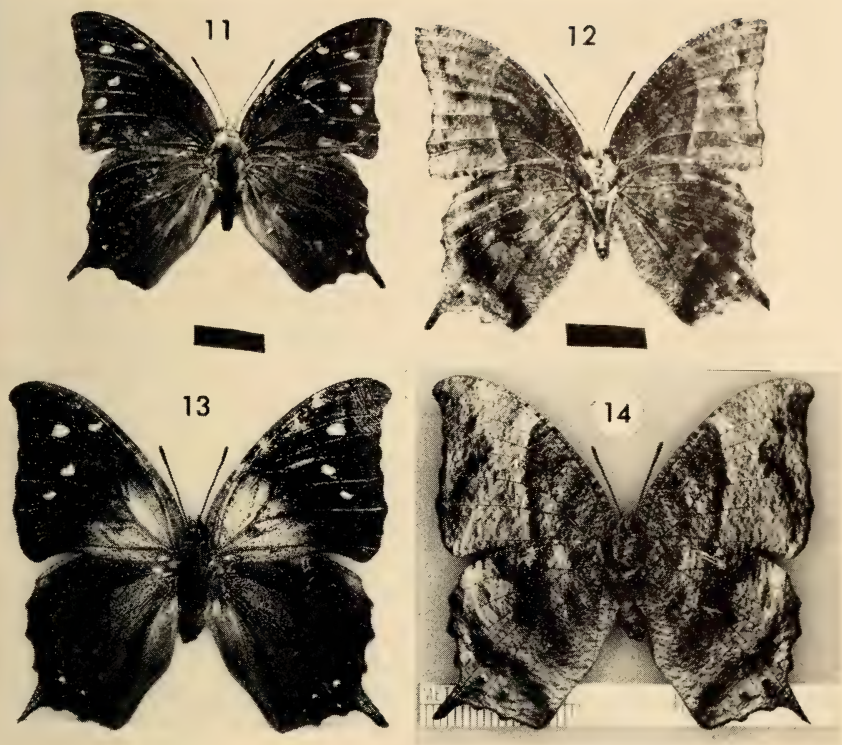
Fourth instar larva (Fig. 5). Head as in third instar, but horns thicker, tubercles more prominent, some of them orange tinged. Body as before, thicker than head at first abdominal segments. Grows to 23.0-28.0 mm in 5-6 days.

Fifth instar larva (Figs. 6, 7). Head as before, looking smaller due to thickness of body. First thoracic segment narrow, forming a "neck". Color of body varies from green to brownish green, with dark markings as in third instar. Grows to 34.0-40.0 mm in 10-12 days.

Prepupa. Body shortens and takes dark purplish tinge. Stays so for one day.

Pupa (Figs. 8-10). Cremaster black, the rest purplish brown, with a darker band of variable intensity dorsally across fifth abdominal segment. Abdomen incurved ventrally, very short from cremaster to ventral limit of wing cases, rounded dorsally, curving inward to thorax. Thorax slightly keeled dorsally, ending smoothly at head. Semicircular row of 4 tubercles present midway along ventral edge of wing covers. Measures 15.0-17.0 mm long, 10.0 mm laterally and dorsoventrally. Adult emerges in 8-12 days.

Adults (Figs. 11-14). Shape and color variable, both in males and females. Forewing apex variably acuminate or not, outer margin sinuose and concave, tornus acute; inner margin sickle-shaped. Hindwing with convex inner margin, sinuose outer margin with variably long, thick tail located at vein M-3, anal angle not pronounced and inner margin almost straight. Dorsal groundcolor dull black with pronounced greenish to bluish reflection basally in males, more so in front wings; light blue in females. Usually 4 blue spots on forewing subapically and along outer margin, conspicuous or completely absent. Hindwing usually shows a small blue spot near the base of the tail and a row of half-moon shaped light blue spots along outer margin. Ventrally both sexes present a combination of different shades of brown, at times almost black, at times light brown. Body short and thick, more so in females. Antennae black.



Figs. 11-14. *Anaea (Memphis) pithyusa*. 11, Male, dorsal view (black bar = 1 cm); 12, male, ventral view; 13, female, dorsal view; 14, female, ventral view.

Natural History

Eggs and larvae of *Anaea pithyusa* are found all year on mature leaves of two local species of *Croton* (Euphorbiaceae): *C. reflexifolius* HBK and *C. niveus* Jacquin. The most common is *C. reflexifolius* which is used to fence coffee plantations to form wind breakers. Both plant species are known locally under the same vernacular name, "Copalchí," and both are very appreciated in popular medicine as tonics and febrifuges. The leaves and bark are very aromatic and bitter. The plants are perennial and grow to about six meters.

The ovipositing female flies swiftly to a group of Copalchí, circles a tree several times more slowly, and finally alights under a mature leaf. One egg is then deposited about at the middle of the leaf, after which the female resumes flying around. The female repeats the process several times before moving away. The small greenish eggs are very hard to spot against the green of the leaves.

The tiny larva completely consumes the egg shell upon hatching and does not feed further for about one day. When ready to feed, the larva proceeds to the edge of the leaf, usually to the tip. Here it constructs a resting perch by nibbling around a vein until it is exposed, affixing frass to it with silk. This perch is used through the first, second and third instars. Once the fourth instar is reached, the perch is abandoned and the larva wanders about the plant until another leaf is chosen. There the larva makes a funnel by rolling an edge of the leaf and tying it to the leaf surface with silk. The funnel is then lined with silk. This refuge is used by the larva when not feeding. The massive head of the larva effectively blocks the wider end of the funnel, and the excreta is expelled out the narrow end. When the feeding larva goes back to its funnel, it positions the caudal end of the body at the wide entrance and crawls backwards until the head plugs the entrance.

The larva produces a pungent but not disagreeable odor when molested, probably from an eversible gland located between the head and the prothoracic legs. If this defense method does not work and a larva is compressed, it regurgitates a green liquid.

When the larva is ready to pupate, as indicated by a change of color, it abandons the funnel and wanders about the plant until a suitable location is chosen. This is usually the inner side of a mature leaf hanging vertically, but sometimes a twig is chosen. A silk pad then is woven, where the anal prolegs are affixed. The larva stays there, curled sideways—not hanging, until pupation. Before becoming a pupa, the larva clears the digestive tract by expelling green liquid mixed with frass through the anus.

The dark purplish brown pupa is passive and seldom reacts when touched and then only by a very slight lateral swing. Prior to adult emergence, the pupa turns black.

The emerging adult breaks the dorsal meson of the thorax and forces down the head and antennal covers, making a fast exit. Hanging from the pupal shell, it starts expanding the wings while ejecting a reddish meconium. The process takes about 15 minutes.

Adults favor wooded areas with neighboring open land. Males are seen resting with folded wings on tree tops, where they exhibit a strong territorial behavior, rushing at any passing butterfly. Both males and females come to the ground to feed on decaying fruits and vertebrate feces. We have never seen males courting females. This may be done high up in the trees.

The species is much affected by parasites from the egg through the pupal stage. Many eggs in the field turn black and give forth tiny

chalcidoids (up to six per egg). During the larval stage, tachinid larvae kill the host and abandon the shriveled body to pupate. We have obtained an unbelievably large adult tachinid from the rather small pupa of the species. It was determined by Dr. C. W. Sabrosky of the USDA as "*Archytas* sp., probably a new species."

We noticed a marked reduction in the number of larvae in the field during the peak of the dry season (February–April). This cannot be attributed to the lack of food, as would be the case with species feeding on annual weeds or deciduous trees because the foodplants of *A. pithyusa* are perennials with leaves showing little loss of succulency. Perhaps the heavy winds which usually blow during the dry season dislodge the eggs from the leaves by rubbing the leaf surfaces together. This may be facilitated by the heavy layer of dust deposited on the leaf surfaces by the wind, hindering the effective attachment of the eggs.

The adults of the species, in addition to a noticeable sexual dimorphism based mostly on color differences, show a confusing assortment of wing shape and color variations.

Discussion

As far as we know this is the first published, illustrated description of the complete life cycle of *Anaea pithyusa*.

This species shares its foodplants with *Anaea* (*Memphis*) *eurypyle confusa* Hall (Muyshondt, 1974a), one of the reddish *Anaea*. Larvae of the two species can often be collected simultaneously from the same tree. Even so, there is no apparent interaction between the larva of the two species, due perhaps to the rather sedentary behavior of both species and the profusion of leaves on the trees.

The eggs of *A. pithyusa* cannot be distinguished from the eggs of *A. eurypyle*. In fact, they are also similar to the eggs of *A. (Consul) fabius* (Cramer) (Muyshondt, 1974b), *A. (C.) electra* (Westwood), and *A. (Memphis) morvus boisduvali* W. P. Comstock (Muyshondt, 1975), which are found on other plants. First instar larvae also look very much the same in all these species and have similar behaviors, but the color of *A. pithyusa* is markedly green, while *A. eurypyle* is brownish. As the larvae progress into subsequent stadia the differences become more evident: head shape and head and body color make identification easy. The differences between all these species reach a maximum at the pupal stage, both in shape and color. Based on these differences, we dare to disagree with Comstock (1961), who groups both *A. pithyusa* and *A. eurypyle* under the subgenus *Memphis*. We do not agree with the placing of these species with *A. (M.) morvus* (Fabricius). There is a

drastic larval and pupal discrepancy between *A. morvus* and these two species indicating a greater phylogenetic distance between them. We think that within Comstock's conception of *Anaea* the local species form five distinct groups as follows: *A. (Zaretis) itys* (Cramer) and *A. (Siderone) marthesia* (Cramer) forming one group, *A. (C.) fabius* and *A. (C.) electra* a second, *A. (M.) eurypyle* a third, *A. pithyusa* a fourth, and finally *A. (M.) morvus* a fifth.

It is a pity we have been unable to find the foodplants of the few other species found in this country to complete our observations, and thence support our claim. But we do have partial evidence regarding *A. morvus*, as A. Muysshondt, Jr. collected a larva in Panama very much like it, on a tree (Euphorbiaceae) resembling *Croton* sp. This larva produced a typical *morus* pupa. Unfortunately the pupa died before forming an identifiable adult, but the undeniable resemblance of the larva and pupa to our local *morus* would seem sufficient to prove they correspond to the same group. In addition, two illustrations in Rydon (1971) of the larvae of *A. (M.) porphyrio* (Bates) (= *leonida* (Cramer) according to Comstock, 1961) and *A. (M.) morvus* resemble ours of a *A. morvus boisduvali* (Muysshondt, 1975) fifth instar larva. Rydon (1971) illustrates the larva of *Anaea phidile* Geyer, and this larva conforms to our *eurypyle*. There must be others resembling our *pithyusa*. An invitation is made to other workers in Central and South America to present their findings on the early stages of species belonging to the genus *Anaea* (*sensu lato*).

We adopted Comstock's (1961) nomenclature from the start of the series, so for the sake of clarity we maintain it, despite our recent acquaintance with the work of Rydon (1971). Rydon has presented a systematic revision of the Charaxidae (with family status) which separates Comstock's subgenera *Zaretis*, *Siderone* and *Coenophlebia* from the rest of *Anaea* and places them into the subfamily Zaretidinae with full generic status. He similarly places the subgenera *Hypna*, *Anaea*, *Polygrapha*, *Consul* and *Memphis* in the subfamily Anaecinae as full genera. Rydon also resurrects *Cymatogramma* from synonymy with *Memphis* and describes the genus *Fountainea* as new. He splits Anaecinae into the following tribes: Hypnini, Anaecini, Consulini, Cymatogrammini, Polygraphini, Fountaineini and Memphidini. *Anaea (Consul) fabius* and *A. (C.) electra* are placed in the Consulini, *A. (Memphis) eurypyle* in Fountaineini, *A. (M.) pithyusa* in Cymatogrammini and *A. (M.) morvus* in Memphidini. Rydon warns that as the early stages of more species become better known, some of the species now placed in *Memphis* may be shown to belong elsewhere.

Funnel formation by fourth instar larvae is found in all species listed above under the *Anaebinae*. *A. (Z.) itys* and *A. (S.) marthesia* larvae do not make leaf funnels. The funnels of *A. (M.) pithyusa*, *A. (M.) eurypyle*, *A. (C.) fabius*, *A. (C.) electra* and *A. (M.) morvus* are located at the tip or the sides of a leaf. It has been assumed (Rydon, 1971) that the funnel is used as protection against the heat or sunlight, but in our experience it seems to be a protective device against predation, as these species make funnels even if maintained continuously in the shade in our insectary. Only some parasitized or diseased individuals fail to make funnels.

The habit of making resting perches with frass pellets exhibited by the species mentioned is shared not only by the other *Charaxinae* we have studied, but by a host of other *Nymphalidae* (*sensu lato*) as well, including *Catonephelinae*, *Coloburinae*, *Apaturinae*, *Biblinae*, *Callicorinae*, *Hamadryadinae* (except *Hamadryas amphinome* (L.) which has evolved gregarious habits during the larval stage), *Limenitinae* (except the genus *Dynamine* which we doubt belongs to the group) and *Marpesiinae* (nomenclature according to Ebert, 1969). This common factor may prove of value in establishing phylogenetic relationships.

Adults of *A. (M.) pithyusa*, *A. (M.) eurypyle*, and *A. (M.) morvus* have similar rapid flight habits. *A. (C.) fabius* and *A. (C.) electra* fly much more slowly.

The defense mechanisms of *A. pithyusa* against predation, based on crypsis and chemical deterrents, do not protect the early stages against parasitism. This seems to support our contention, expressed in our papers dealing with *Pseudonica flavilla canthara* Doubleday (Muyshondt, 1973 (1974)) and *Pyrroglyra hypsenor* Godman & Salvin (Muyshondt, 1974c), that species chemically protected against predation by the noxious components of the foodplants may be preferred by dipterous and hymenopterous parasites because of the increased survival of the host, thus increasing the survival of the parasites.

Anaea pithyusa is one of the local *Charaxinae* most frequently reared by us, and the adults are extremely variable. This indicates a single species with marked polymorphism, or two species with very similar early stages and identical foodplants. These species might interbreed in nature, producing hybrids of intermediate shape and color. In order to clarify the situation seven adults reared *ex ova* were sent to the American Museum of Natural History, representing the two extremes and several intermediate forms. The specimens with no blue subapical spots or with the spots much reduced were determined as *A. pithyusa*. Specimens with larger blue subapical spots were determined as *A. (M.)*

perenna Godman and Salvin. S. Steinhäuser (pers. comm.) stated once that in his experience, it was very difficult, if at all possible, to tell *pithyusa* from *perenna* by examination of male genitalia. On the basis of the similar morphological and behavioral characteristics of the early stages and the use of the same foodplant, plus the determination made at the American Museum of Natural History, we dare to suggest the two species are only one, with a host of different morphs. If that is the case, the name with priority would then be *A. pithyusa*.

ACKNOWLEDGMENTS

We are obliged to Dr. A. H. B. Rydon for kindly supplying a copy of "The Systematics of the Charaxidae" and the valuable information made available in his correspondence, and to Dr. F. H. Rindge from the American Museum of Natural History for the determination of the species. We also thank Dr. C. W. Sabrosky of the USDA for determining the tachinid parasites, S. Steinhäuser for sharing with us his personal observations on the species, and Dr. G. L. Godfrey and Mr. M. Toliver for revising the manuscript and making constructive criticisms.

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AMBLYSCIRTES CAROLINA AND A. REVERSA (HESPERIIDAE)
IN MISSISSIPPI AND GEORGIA¹

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Dos Passos (1964) listed "form *reversa* Jones, 1926" under *Amblyscirtes carolina* (Skinner), 1892. In doing so, he followed Evans (1955). Freeman (1973) wrote "*Carolina* seems to be confined to the North Carolina-Virginia area," and "*Reversa* has long been considered to be a synonym of *carolina* or at most a form. I believe that actually it is a distinct species due to morphological differences . . . There are also slight differences in the genitalia. This species ranges farther south than *carolina* being found in Georgia as well as in the same areas as *carolina*."

This note reports the rearing of *reversa* in Georgia and the occurrence of *carolina* in both Georgia and Mississippi and of *reversa* in Mississippi.

Harris (1972) listed records for both *carolina* and *reversa* from the Piedmont region and for *reversa* from the Georgia coastal plain. Harris mentioned that *reversa* had been reared by John Symmes. In view of the new status assigned to *reversa* by Freeman (1973) and discussions with J. R. Heitzman, I wrote to Mr. Harris, custodian of the collection of the late Mr. Symmes, who was kind enough to obtain and supply more information and to permit the results to be published.

In 1963, from one batch of ova, Symmes reared at least 17 adults of *reversa* that are now in his collection. The locality was Long Island Creek, off Harris Trail, Fulton Co., Georgia. The food plant was *Arundinaria tecta* (Maiden cane). The adults included 7 males that emerged: 8 July (1), 10 July (2), 12 July (1), 17 July (1), 28 July (2); and 10 females: 14 June (1), 25 June (1), 26 June (1), 28 June (3), 30 June (1), 8 July (1), and 10 July (2). The Symmes collection includes 6 wild-caught specimens, from the same locality, as follows: 4 May 1963 (1 ♂), 15 July 1955 (2 ♂♂), 12 May 1959 (1 ♀), 20 May 1961 (1 ♀), and 5 July 1962 (1 ♀). As noted by Harris (1972), *carolina* has been known from Fulton Co. since 1910; the fact that Symmes' rearing produced only *reversa* tends to confirm Freeman's conclusion that *reversa* and *carolina* are not conspecific.

Mather & Mather (1958) knew of only a single specimen of *carolina*

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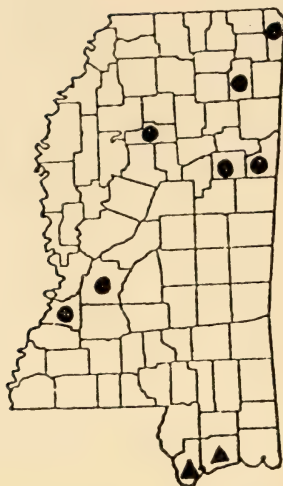


Fig. 1. Distribution of *Amblyscirtes carolina* (●) and *A. reversa* (▲) in Mississippi.

from Mississippi, taken at Brownsville, Hinds Co. on 2 Sept. 1957 by M. & E. Roshore. A second specimen was reported (Mather & Mather, 1959) taken by the same collectors at the same locality on 15 June 1958. Now 25 specimens of *carolina* and 16 of *reversa* are known from Mississippi. The additional records of *carolina* and the records of *reversa* are as follows:

A. carolina Skinner

Claiborne Co.: Rocky Springs, 2 April 67 (1) (M. & E. Roshore), 16 Aug. 70 (1) (B. Mather). Lowndes Co.: Columbus, 10 June 67 (1 ♀) (Macdonald Fulton). Grenada Co.: Grenada, 23 Aug. 70 (2 ♂♂), 17 June 71 (1 ♂) (Charles Bryson). Tishomingo Co.: Haynes Lake, 15 April 72 (1 ♂) (John Bryson); Mt. Woodall, 15 April 72 (1 ♀) (Charles Bryson). Lee Co.: Tombigbee State Park, 1 April 73 (1 ♂) (John Bryson); 5 April 73 (1 ♀) (Charles Bryson); 17 Aug. 73 (1 ♂, 1 ♀) (Ricky Patterson). Oktibbeha Co.: Craig Springs, 31 July 73 (1 ♂), 8 Aug. 73 (4 ♂♂, 2 ♀♀), 9 Aug. 73 (1 ♂, 2 ♀♀) (Charles Bryson); Dorman Lake, 2 Aug. 73 (1 ♂) (Charles Bryson).

A. reversa Jones

Harrison Co.: Biloxi, 14 June 64 (1) (R. & B. Taylor) (determined by J. R. Heitzman); Big Biloxi Recreation Area, 26 Aug. 70 (6), 8 April 71 (2), 9 April 71 (1), 10 April 71 (2) (Rick Kergosien). Hancock Co.: Darwood, 24 June 71 (2 ♂♂, 1 ♀), 8 Aug. 71 (1 ♂) (Rick Kergosien).

These records suggest that, in Mississippi, *reversa* occurs on the Gulf coastal plain and *carolina* in the interior of the state (Fig. 1). *A. reversa*

has been taken in April, June and August; *carolina* in all months April through September, except May.

ACKNOWLEDGMENTS

The assistance of the following is acknowledged with appreciation: Mr. Lucien Harris, Jr. for data from the collection of John Symmes; Mr. J. R. Heitzman who called my attention to the significance of Symmes' data; Mr. and Mrs. E. C. Roshore, Mr. and Mrs. R. T. Taylor, Jr.; Mr. Rick Kergosien, Professor Macdonald Fulton, and Mr. Charles T. Bryson, who provided Mississippi records; and Mr. Charles T. Bryson for compiling the Mississippi data.

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NOTES ON THE BIOLOGIES OF *PAPILIO LAGLAIZEI* AND
P. TOBOROI (PAPILIONIDAE)

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Papilio laglaizei Depuiset and *P. toboroi* Ribbe are included in a small and closely related species group that is morphologically distinctive from other species in the genus (Munroe, 1958). *P. laglaizei* is found on mainland New Guinea, and *P. toboroi* occurs on Bougainville, Santa Ysabel and Malaita Island. A third species, *P. moernerii* Aurivillius, is known from New Ireland. What some recognise as *P. mayrhoferi* Bang-Haas from New Britain probably is only a geographical race of *P. moernerii* as was originally described by Bang-Haas (1939).

In addition to the two specimens of typical *P. moernerii* mentioned by D'Abrera (1971), there is one in the Australian National Insect Collection, Canberra, and the author has also seen a few specimens taken on New Ireland in 1968. In view of the foregoing, and the fact that at least some known localities of the species on New Ireland have hardly been disturbed during this century, D'Abrera's (op. cit.) suggestion that the species is "probably extinct" is considered unlikely to be correct.

The adult of *P. laglaizei* shows a remarkable similarity to the common and presumably distasteful diurnal moth *Alcides agathysus* Kirsch (Uraniidae). The two species also share some of the same habitats. These factors suggest a possible mimicry situation. *Papilio toboroi* and *P. moernerii*, although co-existing in the same habitats with other diurnal *Alcides* species, do not particularly resemble them.

The biology of this *Papilio* species group is remarkable in other aspects, e.g., the laying of eggs in large masses and the highly gregarious behaviour of the larvae (D'Abrera, 1971). More complete notes for *P. laglaizei* and *P. toboroi* are given below.

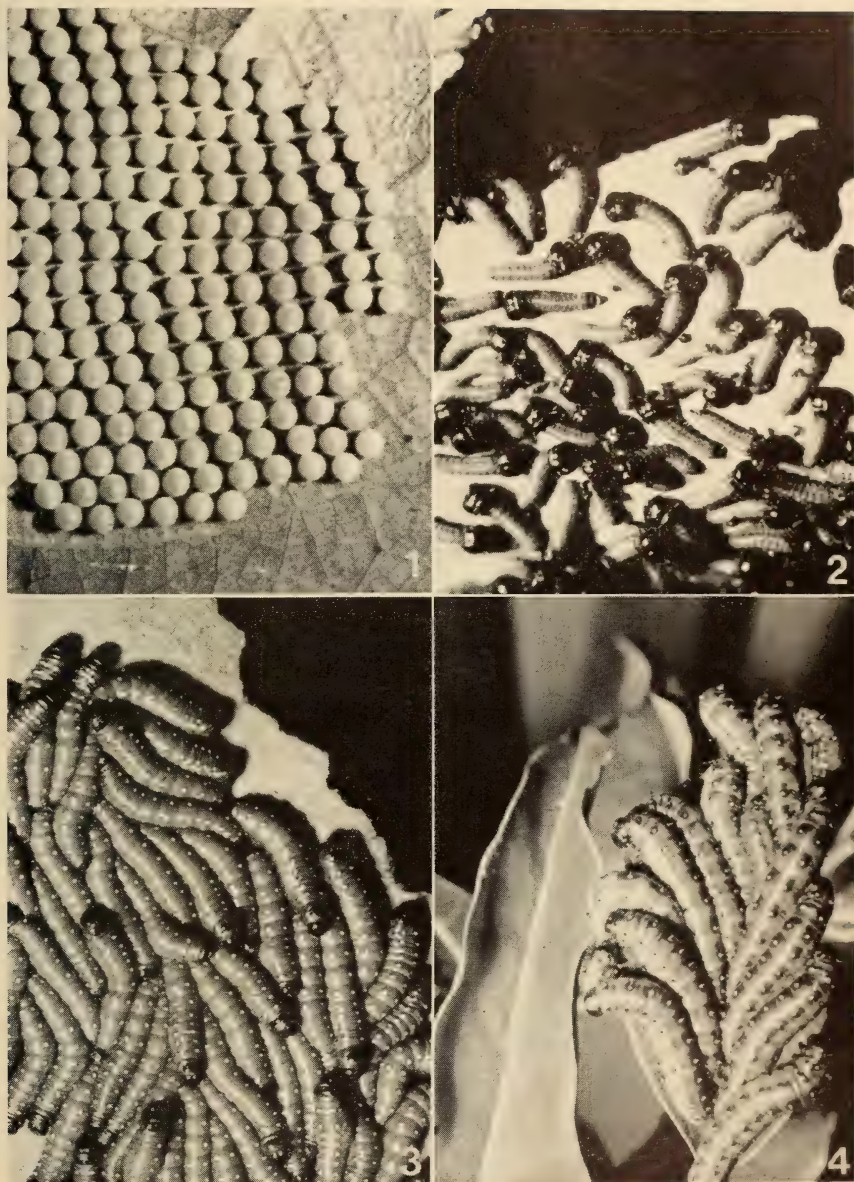
Papilio laglaizei Depuiset

Early Stages

Egg (Fig. 1). Small, diameter 0.9 mm. When freshly laid its colour reddish yellow. A few hours later numerous reddish brown lines appear below top of egg and extend towards, but not reaching flattened base. Deposited in parallel rows of up to 500 eggs per batch on undersurface of leaf of foodplant, *Litsia* sp. (Lauraceae).

First instar larva (Fig. 2). Head and prothoracic shield comparatively large, shiny black. Body bronze green, laterodorsally with 2 rows of tiny black processes, each carrying a fine, black hair with a small white dot at base.

Second and third instar larvae (Fig. 3). Groundcolour light brown. Head, legs and prothoracic shield black. Laterodorsal processes black, average length about 0.33



Figs. 1-4. *Papilio laglaizei*: (1) eggs on hostplant, *Litsia* sp.; (2) first instar larvae; (3) second and third instar larvae; (4) fourth instar larvae.



Figs. 5-8. *Papilio laglaizei*: (5) fourth instar larvae; (6-7) last instar larvae; (8) prepupa (inverted).

mm. Each segment has 6 white spots, 1 at the base of each dorsal process, 2 laterally and 2 ventrolaterally.

Fourth instar larva (Figs. 4, 5). Laterodorsally with a broken and ventrolaterally with a longitudinal, vague, dark, broad stripe. Posterior segments black, with a broken ring formed by white spots and stripes. Dorsal tubercles about 0.5 mm long with broad, round black bases, having large round white central spots. Osmaterium light green.

Final instar larva (Figs. 6, 7). Groundcolour varies from dull brown to reddish brown. Prothoracic shield black, middorsally divided by white line. Posterior segments black with 2 white spots middorsally and white stripes laterally, forming a broken ring. Laterodorsal tubercles about 1.0 mm long, with broad, black bases that in some individuals have small white central spots. All segments joined by broad, black ring, widening laterally into large, triangular spot below spiracles. Middorsally each ring has white, elongated spot. Thoracic segments have 4 and abdominal segments 6 white spots laterally and ventrolaterally. Measurements of mature larva: headcapsule length 5.5 mm, width 4.1 mm; total length 74.0 mm.

Prepupa (Fig. 8). As soon as the larva has settled for pupation its general colour fades to pale ochreous yellow.

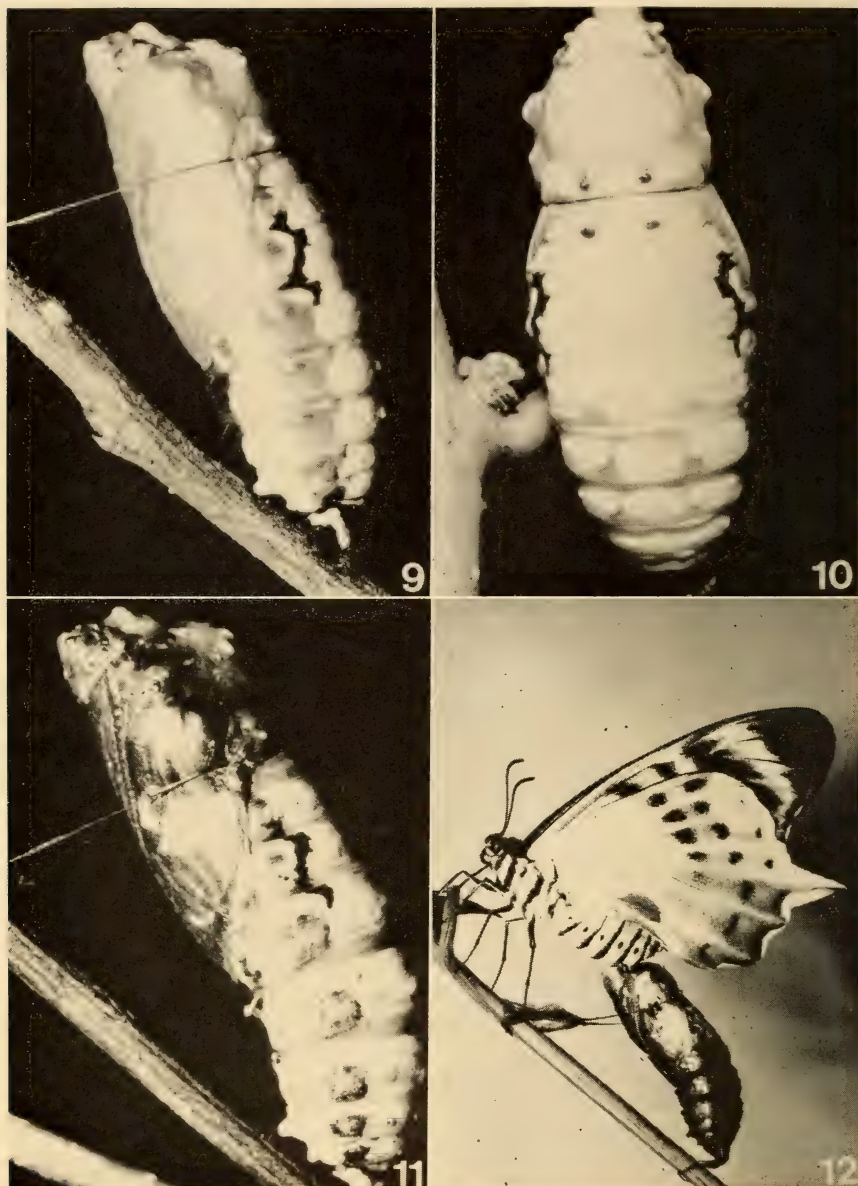
Pupa (Figs. 9–11). Groundcolour cadmium yellow. Smooth, roundish and hard in general appearance. Abdominal segment 8 with a long and segment 9 with a shorter, blunt appendage lateroventrally. Cremaster broad, strong. Black ventrally, yellow laterally and dorsally cephalad with a black ring. Dorsally the thoracic and first abdominal segments with 4 blunt humps each. Abdominal segments 1 and 2 dorsally with 2 round, black dots each. Segments 5–9 laterally with broken, broad, brown stripe surrounding the spiracles; segments 6 and 7 each with 2 triangular, light brown spots dorsally, while segments 3, 4 and 5 are laterally joined by a short, W-shaped black line.

Duration of stages. First instar, 4–5 days; second instar, 4 days; third instar, 5 days; fourth instar, 4–5 days; final instar, 6–7 days; prepupa, 2 days; and pupa, 14–16 days.

General Observations

Behaviour of larvae. The larvae are strongly gregarious at all stages. Shortly after hatching they group themselves on the underside of a leaf, pressing together around a few individuals as a solid ring, radially orientated with heads outward. All larvae feed simultaneously for about 25 minutes, and then return to their resting position for about four hours after which time feeding is resumed.

During the penultimate and ultimate instars the larvae, being too large to rest on leaves, aggregate on branches or on the main stem of their hostplant. From a distance they closely resemble larvae of sawflies (Perginae) or some saturniids, e.g., *Opodiphthera*. After the final feeding, the mature larvae remain motionless and clustered together for about a day, during which time their groundcolour becomes bright orange brown. At a certain moment, generally towards sunset, all individuals start to move simultaneously and rapidly walk down the main stem of their hostplant. This often happens to be a tree standing near a riverbank with several of its branches overhanging the water. Many



Figs. 9-12. *Papilio laglaizei*: (9) pupa, lateral view; (10) pupa, dorsal view; (11) pupa, lateral view, seconds before adult emerged; (12) adult male.



Figs. 13-16. *Papilio toboroi*: (13-14) fourth instar (moulting) and fifth instar larvae; (15) pupa, lateral view; (16) adult female.

larvae fall into the water in their wandering and may be carried over long distances. Some drown but many keep floating, hanging onto debris, which, if carried by the current to the riverbank, enables them to crawl up and settle on nearby overhanging branches of shrubs and weeds. On several occasions pupae were found on low shrubs growing on small islands in the middle of shallow rivers. However, some individuals pupated on twigs or on the underside of leaves of their hostplant. This applied generally to parasitised larvae which may not have had the strength to move a long distance.

Predators and parasites. All stages face many predators. Some egg batches were found parasitised by minute wasps or attacked by small landsnails. Others were eaten by ants although some batches escaped undetected. Mainly fourth instar larvae are heavily parasitised by Braconidae, Ichneumonidae and Tachinidae. Mature larvae face other dangers when ready for pupation as frogs and toads were seen attacking them during their search for a pupation site. It is estimated that in the field no more than 2-3 percent of an egg batch produces adults.

Behaviour of adults. Male butterflies fly high in an erratic way. They may establish a territory which often consists of an opening between trees at the edge of the forest. In a space often not larger than a few square meters, they fly up and down chasing any flying creature in sight. Females have a more sluggish flight. The sex ratio of 115 pupae obtained in captivity from the egg was 64 females : 48 males, while three pupae died.

P. laglaizei is found from sea level to 1500 meters, its optimal range being 500-1200 m.

Papilio toboroi Ribbe

Early Stages

The observations started with third instar larvae because no younger stages were available.

Third instar larva. Groundcolour light brown. Thoracic segments with 6, and abdominal segments with 8 white spots each, forming a row starting from base of dorsolateral tubercles down to prolegs. Tubercles black with 1 large and sometimes 2 small white spots near base. Head, legs and prothoracic shield black.

Fourth instar larva (Figs. 13-14). Abdominal segments black with broken ring formed by white spots and stripes. Laterodorsal tubercles approximately 5.0 mm long. A longitudinal, broken dark brown stripe appears ventrolaterally covering the prolegs.

Final instar larva (Figs. 13-14). Groundcolour brown. Head, legs, prothoracic shield and anal segment black, prolegs black spotted. Prothoracic shield middorsally narrowly divided by white line. Thoracic segments with 6 and abdominal segments with 8 white spots each. Tubercles between 8.0 and 9.0 mm long, stiff, black with broad white spots at their bases. All segments joined by a black ring, which is comparatively narrower than in *P. laglaizei* and misses the middorsal white spot.

Pupa (Fig. 15). Very similar to *P. laglaizei*. Main differences are comparatively shorter ventral appendages on abdominal segment 9 and the black, lateral markings on abdominal segments 3, 4, and 5 which do not form a W-shaped line, but are broken into short black stripes. The duration of the pupal stage averaged 16–18 days.

General Observations

Behaviour of larvae. The larvae are strongly gregarious as in *P. laglaizei*. Two separate batches of larvae were observed in the same area. The largest group consisted of at least 700 larvae. Feeding occurred simultaneously and mostly at night. The average size of the leaves of the hostplant was rather large, allowing the larvae in all instars to rest together on both sides of leaves instead of congregating on stems and branches as is the case with mature larvae of *P. laglaizei*. The position of the hostplant trees, possibly belonging to the Lauraceae, was on high hills, approximately 1300 m above sea level, in secondary growth near village gardens and a considerable distance from water. The larvae remained close together until the time they were ready to disperse in search for suitable pupation sites.

Predators. During their nocturnal wanderings, lasting a whole night, the larvae were attacked by toads, frogs, geckos, spiders and ants. Only a fraction of the mature larvae ever reached a suitable spot to settle for pupation. Of these about 20 percent produced parasitic species of the Tachinidae and Braconidae.

Behaviour of adults. Male and female butterflies were seen flying around and feeding from flowers in village gardens. No males were seen in "territorial flight" as was the case in *P. laglaizei*. However, in spite of the very large numbers of larvae present in the area, comparatively few adults were seen on the wing.

ACKNOWLEDGMENTS

Thanks are due to Mr. Ted Fenner, Entomologist, Department of Agriculture, Konedobu for critically correcting and improving this manuscript and to Mrs. D. Bowden and R. Carr, Sogeri, for typing the manuscript. Dr. D. Frodin, University of Papua New Guinea, kindly identified plant specimens.

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THE GEOGRAPHICAL DISTRIBUTION OF *CALLOSAMIA*
SECURIFERA (SATURNIIDAE)

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This study began with a desire to obtain specimens of the Sweetbay Silk Moth, *Callosamia securifera* (Maassen), of the southeastern United States, but scant information was available to aid in collecting the species. It was surprising to learn all the misconceptions that have centered around this distinctive moth, even among experienced lepidopterists. Ferguson (1972) has cleared up problems of the incorrect type locality given by Maassen, the synonymy of the name *carolina* Jones (Jones, 1908), and the fact the species is distinct from *C. angulifera* (Walker).

I obtained information on the distribution of this species in several ways. In the spring of 1971 I placed a research request notice in the *News of the Lepidopterists' Society* asking for locality data and gave both names for the species. J. P. Donahue, Los Angeles County Museum of Natural History, wrote giving data of their only specimen: Pensacola, Florida. (That museum now has more specimens.) Dr. L. N. Brown, University of South Florida, gave Plant City, Hillsborough Co.; Highlands Hammock State Park, Highlands Co. (ca. 10 mi. S Lake Placid); Bunnell Exit of Interstate 95, Flagler Co., and a location 10 mi. E Bartow, Polk Co., all in Florida. I have seen Dr. Brown's collection and the determinations are correct.

A second method of obtaining localities was through the literature, but most authors gave only type localities. Maassen & Weymer (1873) gave Central America as the type locality, but Draudt (1929) and Ferguson (1972) rejected this as incorrect. Jones (1908) redescribed the species as *angulifera* var. *carolina* from Berkeley Co., South Carolina. Brimley (1938) notes *angulifera* larvae taken on sweetbay (*Magnolia virginiana* L. = *glauca*) in North Carolina, but as *securifera* larvae are similar and *angulifera* refuses to accept sweetbay (pers. obs.), I assumed this to be ample evidence that *securifera* occurs in North Carolina.

Additional records were given by Packard (1914), who figured a female from Winter Park, Orange Co., Florida, and Kimball (1965), who gave the following Florida localities: Quincy, Gadsden Co.; Warrington, Escambia Co.; Monticello, Jefferson Co.; Gainesville; Tampa; Fruitville, Sarasota Co.; Parker's Island and Archbold Biological Station

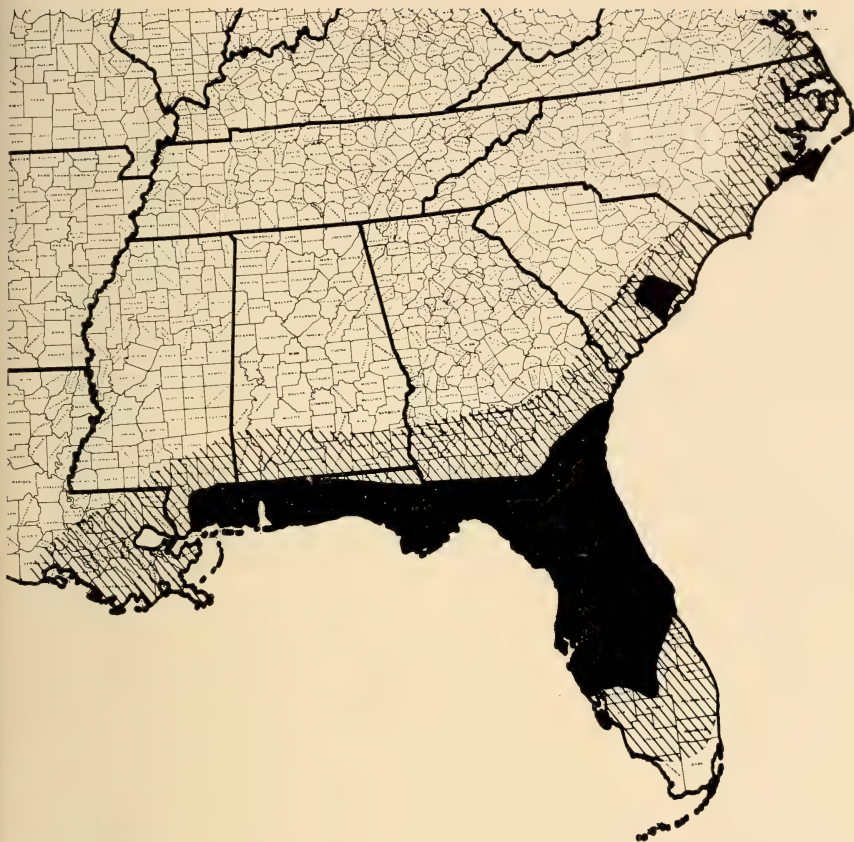


Fig. 1. The documented (black area) and hypothetical (lined area) geographical distribution of *Callosamia securifera*.

near Childs in Highlands Co. The latter two places are within a few miles of Highlands Hammock State Park. Ferguson (1972) gave several additional localities: Oneco, Manatee Co., Florida; Charleston Co., South Carolina; Mobile, Alabama; and Harrison and Stone counties, Mississippi.

I saw a female from Ocean City, Okaloosa Co., Florida (Dale E. Pffor collection) and Dale Schweitzer saw and verified a female in the collection of J. B. Sullivan from Carteret Co., North Carolina, so a valid record for that state now exists. Wm. H. Howe has a female from Loxley, Baldwin Co., Alabama. I was kindly supplied with a Georgia record by John W. Cadbury of Browns Mills, New Jersey who saw and collected *securifera* in the Okefenokee Swamp in 1937 and 1940.

The last way to elucidate the range of the Sweetbay Silk Moth was to collect it myself. I searched in Florida, Georgia, South Carolina, and North Carolina with success in all but the last named state. I collected cocoons in Gainesville, Florida in the vicinity of 39th Street two different years. In Long Co., Georgia I found a cocoon beside Highway 82 between Ludowici and Allenhurst. In Columbus and Brunswick counties, North Carolina much suitable habitat abounds but I did not find even an empty cocoon. However, the species should be present as it is now known from Carteret Co. north of there. In South Carolina I searched many coastal and inland counties but only found the species on the boundary of Charleston and Berkeley counties, near the Wedge Plantation, and beside Highways 6 and 311 several miles west of Moncks Corner, the latter being the most inland specific record for the state.

Fig. 1 represents a summary of the known records described above and a hypothetical geographical distribution of *securifera* based on published maps of the range of sweetbay (Brockman, 1968; Collingwood & Brush, 1955) and the knowledge of the distribution of many better known elements of the Floridian flora and fauna northward and westward on the coastal plain. It is extremely doubtful if *securifera* ever utilizes any other host besides sweetbay, but if it does take other *Magnolia* species such as *ashei* Weatherby or *pyramidata* Bartr., this would not suggest a wider range because the ranges of these trees fall within that of sweetbay (Brockman, 1968). Sweetbay ranges down the coastal plain from Massachusetts and across to Texas, up from the Gulf Coast into Arkansas and southwestern Tennessee, but only in the eastern halves of the Carolinas, commonly only near the coast. There is no valid reason to assume *securifera* does or could exist everywhere its host tree does.¹

There are so many different types of habitats between points where the moth is recorded that it is also a mistake to assume the species occurs throughout the intervening areas. For examples, the marshland around Savannah, Georgia has scarcely any sweetbay and central Florida has so many dry oak forests that populations of *securifera* and sweetbay are often in isolated wet areas totally surrounded by miles of unsuitable habitat.

ACKNOWLEDGMENTS

I thank Dr. Richard B. Dominick as well as persons named in this paper who aided and encouraged my study of this moth. Dr. G. R.

¹ Note added in proof: On 22 March 1975 I collected cocoons of *securifera* along Highway 211, Brunswick Co., N. C., the southernmost county of that state.

Carner of Clemson University taught me principles of scientific research and writing, and my parents were especially helpful regarding collecting trips.

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THE TYPE LOCALITY OF *SATURNIA WALTERORUM* (SATURNIIDAE)

The type locality of *Calosaturnia meridionalis* (name changed to *Saturnia walterorum* by Hogue & Johnson 1958, J. Lepid. Soc. 12: 17) was fixed by Johnson (1940, Bull. Brooklyn Entomol. Soc. 35: 100-102) as Santiago Canyon, Santa Ana Mountains, Orange County, California. Santiago Canyon, however, extends for approximately 10 miles, from an altitude of 4600 ft. near Santiago Peak down to an altitude of approximately 1000 ft. Since the canyon has different plant associations at different elevations, and since *walterorum* is not known to occur through the entire length of the canyon, it seems desirable to fix the type locality and habitat more precisely.

I am indebted to Erich Walter (Anaheim, California), for information on the precise locality where he captured the type specimen. The type was captured on 15 March 1925 at an elevation of 1600 ± 20 ft. along Santiago Creek, in the Cleveland National Forest, at the junction of the first wash branching north (east of Modjeska Canyon). On the Santiago Peak, California, 7.5 Minute Geological Survey Quadrangle Map, 1954 edition, the coordinates are 44300 meters east, 29300 meters north (T5S, R7W, SW corner NE $\frac{1}{4}$ SW $\frac{1}{4}$ Section 27).

This information supplements a recent article on the distribution and larval food-plants of this rare moth (Tuskes 1974, J. Lepid. Soc. 12: 17).

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PUPAL ANOMALY OF *RHYACIONIA NEOMEXICANA*
(OLETHREUTIDAE)

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The southwestern pine tip moth, *Rhyacionia neomexicana* (Dyar) (Lepidoptera: Olethreutidae) is a destructive pest of young ponderosa pine, *Pinus ponderosa* Lawson. The biology of this insect has been outlined by Jennings (1972). Larvae feed in upper crown terminal and lateral shoots. Late-instar larvae descend the tree boles and pupate in cocoons attached to root collars of host trees. Cocoons are found at an average depth of 2.6 cm beneath the surface of the soil. The pupal stage, which lasts from July–March, is the overwintering stage of the tip moth.

On 10 November 1971, *R. neomexicana* pupae were dug from root collars of plantation ponderosa pines on the Piedra Ranger District, San Juan National Forest, Archuleta County, Colorado. They were subsequently examined under a dissecting microscope and sexed by position and configuration of the genital pore (Jennings, 1974). One female pupa was found with an abnormally segmented abdomen (Fig. 1b).

Previous reports of lepidopterous pupal anomalies are rare. Lindquist (1964, 1966) reported aberrant olethreutid larvae with extra prolegs. Examples of hysterotely, where structures usually found in an earlier stage appear in a later one, are described by Cockayne (1927) for a tineid pupa and by Haggett (1954) for an arctiid pupa. None of these cases is similar to the *R. neomexicana* pupal anomaly.

Rhyacionia neomexicana pupae overwinter after the moth is fully developed. In this stage they are readily identified by the presence of two black lines in the outer one-third of each forewing, visible through the wing covers of the pupal integument. The pupal abdomen is yellowish brown, with the head, thorax, and wing covers dark brown. There are 10 abdominal segments, although some fusion of the posterior-most segments makes them difficult to distinguish (Fig. 1a). Dorsally, spines are arranged in rows on the abdominal segments. Spines are completely absent on the 1st abdominal segment, while segments 2–7

¹ Biological Technician and Entomologist, respectively, USDA, Forest Service, Rocky Mountain Forest and Range Experiment Station, with central headquarters maintained at Fort Collins in cooperation with Colorado State University; authors are located at Albuquerque in cooperation with the University of New Mexico.



Fig. 1. Pupae of *Rhyacionia neomexicana*: (a) typical female pupa, (b) aberrant female pupa.

each have a cephalic and a caudal row of spines. The cephalic row is usually larger and more prominent than the caudal. The 8th and 9th abdominal segments usually have only a single row of spines. Setae are present on the cremaster, a prolongation of the 10th abdominal segment. Length of female *R. neomexicana* pupae ranges from 6.7–9.8 mm.

The aberrant *R. neomexicana* pupa is 8.3 mm long. Laterally and ventrally the exposed abdominal segments appear normal. Dorsally, the 1st abdominal segment shows no malformation (Fig. 1b). The 2nd segment is enlarged at and to the right of the dorsomeson. The cephalic row of spines on segment 2 is straight while the caudal row is deflected posteriorly. To the left of the dorsomeson, the 3rd abdominal segment is reduced and incomplete. The cephalic and caudal rows of spines on this reduced portion of segment 3 appear to be normal. To the right of the dorsomeson and in the position of the 3rd abdominal segment, an aberrant segment is fused to the 4th abdominal segment. Fusion with the 4th segment is complete near the level of the dorsomeson. A cephalic row of spines angles posteriorly to the left across the dorsomeson and into the region of the 4th segment. The caudal row of spines of this aberrant segment also projects posteriorly but does not reach the level of the mid-dorsal line before joining the 4th segment. To the right

of the dorsomeson and in the position of the 4th segment, a cephalic row of spines is reduced to about one-third the segment width. The caudal row of segment 4 is intact. Spination appears normal on the remaining abdominal segments.

According to Pedder (1965), Balazuc (1948) separated abnormalities of segmentation in Coleoptera into five categories: polymery, symphysomery, helicomery, hemimery, and hemiatrophy. Following this classification, the aberrant *R. neomexicana* pupa displays at least two categories: symphysomery, a partial fusion of two segments, and hemiatrophy, a reduction in part of the sclerites.

What caused this pupal anomaly can only be hypothesized. Pedder (1965), working with pseudoscorpions, concluded that tergal aberrations probably arise post-embryonically during the process of molting. It is conceivable that a mechanical injury during the larval stage could possibly result in an anomaly in the pupal stage similar to the one described here, but the possibility of a genetic aberration cannot be ruled out.

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BOOK REVIEWS

CLEARWING MOTHS OF AUSTRALIA AND NEW ZEALAND (LEPIDOPTERA: SESIIDAE), by W. Donald Duckworth and Thomas D. Eichlin. 1974. Smithsonian Contributions to Zoology, no. 180. 45 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price: \$1.70 U.S.

This is the first taxonomic treatment of the Australian Sesiidae since Gaede's 1933 enumeration of the World fauna in Seitz, and the 1925 World list of Dalle Torre and Strand in *Lepidopterorum Catalogus*. The only previous revisions of the Australian species were by A. J. Turner in 1917 and 1922.

The present revision recognizes 14 species from Australia, including the introduced pest species *Synanthedon tipuliformis*. Only the introduced *S. tipuliformis* is known from New Zealand. One Australian species is described as new and the fauna is assigned to six genera. Eight names represent new combinations in three genera *Pennisetia* Dehne, *Albuna* Edwards and *Carmenta* Edwards, which have not previously been included in the Australian fauna. The two genera *Lophocnema* and *Diaprya*, described as endemic by Turner, have been treated as synonyms of *Pennisetia*. The authors discuss the taxonomic history, morphology, biology and geographical distribution of the family. They conclude that the Sesiidae have invaded Australia relatively recently with a minimal development of endemism, and that most of the Australian species will ultimately be found to occur in neighbouring areas to the north.

As the authors state, the Australian Sesiidae have been seriously neglected and are poorly represented in collections; few species have been reared from the larvae. This up-to-date and well documented taxonomic treatment should do much to interest Australian lepidopterists in the group and to encourage them to search for both adult and immature stages. Although no endemic species are known from New Zealand, careful field work in the far north of the North Island could yield new discoveries.

This revision is well illustrated by photographs of the adults and line drawings of the male and female genitalia, wing venation, and morphological details of the head. Maps show the localities referred to in the text. It would have been useful to Australian workers if the numbers of specimens examined in each species had been indicated, together with the label data and the repository of non-type specimens. Although relatively small, the number of specimens studied must have greatly exceeded that of previous workers. The revision appears to be largely free of inadvertent errors, and only three have been noted. On page 18, column 1, line 25, "Bernard" should read "Barnard," and on page 18, column 1, line 39, "western" should read "eastern." Finally in Maps 1 and 6, *Carmenta chrysophanes* is shown to occur at a point well within the Eyrean faunal province. If this point represents Canberra, where the species is stated to occur, it is too far north and too far inland; Canberra is in fact in the Bassian province.

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THE SESIIDAE (LEPIDOPTERA) OF FENNOSCANDIA AND DENMARK, by M. Fibiger and N. P. Kristensen. 1974. Fauna Entomologica Scandinavica, vol. 2, Scandinavian Science Press Ltd., Gadstrup, Denmark, Contents + 85 p., 144 figs., including line drawings, 28 color illus., and 34 black and white photographs. Price: 40 D.kr.

Though the faunal coverage indicated by the title includes 17 species, 8 species not known to occur in Scandinavia are also treated. According to the Introduction

it is the editorial policy of the Series to give full treatment to British species, even though their occurrence in Fennoscandia and Denmark may not be likely. Six species not known from Scandinavia or England are examined, three of which are not known from Northwestern Europe but might possibly reach the eastern edge of Fennoscandia, in the opinion of the authors.

All but the latter three species are illustrated in color. In my opinion this is the only way to properly present adult Sesiidae, not to mention most other Lepidoptera. Many black and white photographs depict various aspects of the behavior of the immature stages and their host plant associations, a useful addition to the biological information. In most studies of this nature only fleeting reference is made to sesiid behavior. The publication points out the value of biological data as it relates to the taxonomy of the group.

This work incorporates the most current ideas on the systematics of Palearctic Sesiidae, particularly ideas found in Naumann's 1971 revision of the Holarctic sesiid genera. Reference is made to Kristensen's original studies on sesiid wing transparency, which has since been published. The authors have added much needed terms for the general hyaline areas on wings of most clearwing moths.

As the authors point out, there will continue to be reinterpretations of higher taxa based on the findings and subjective judgments of other workers, including this reviewer. However, "The Sesiidae of Fennoscandia and Denmark" is a concise, accurate, well-illustrated and modern treatment of a particular faunal area. The *Fauna Entomologica Scandinavica* will be a valuable series of contributions to scientific literature if the quality of succeeding portions can match the quality of this volume.

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CATALOGO DE LOS ROPALOCEROS ARGENTINOS, by Kenneth J. Hayward. 1973. Opera Lilloana XXIII. Fundación Miguel Lillo, Tucumán, Argentina. 318 p. Price: about \$3.00 U.S.

As a fitting climax to Kenneth Hayward's years of study of the butterflies of Argentina, we have this posthumously published catalog of the Rhopalocera known to fly there. Hayward had previously published a catalog of the HesperIIDae (1941) and of the remaining Rhopalocera (1950) along with numerous supplements. The present synonymic catalog is a great improvement over the previous works, not only because it combines them into one publication, but because it also includes: (1) where known, larval host plants; (2) distributions in which the provinces are listed circularly clockwise beginning in the northeast, instead of alphabetically, as previously listed; (3) in keeping with modern practice, synonymizing all named aberrations and forms; and (4) a general updating in nomenclature as well as range extensions. Quite a number of new species have been added to the Argentine fauna.

The work varies in quality depending on where the author had concentrated special study. As the higher classification of the butterflies is somewhat subjective, I cannot argue much with the author regarding his rather novel division of the Rhopalocera into five superfamilies (Hesperioidea, Papilionoidea, Riodinoidae (sic), Nymphaloidea, and Danoidea). I would question, however, his placing the Libytheinae as a subfamily of the Riodinidae.

As can be imagined, from an author who published voluminously on the hesperiids, including two mammoth tomes on the Argentine species, the HesperIIDae section is the best. Hayward has closely followed Evans' revision but has felt free to diverge, especially in many cases where Evans placed certain of Hayward's taxa into synonymy. If the hesperiid section is the best, the most deficient areas would be those on the Pieridae and the Lycaenidae. In the Pieridae many subspecies are placed in

synonymy as forms or mentioned in brief footnotes. The treatment of the *Eurema* species is highly questionable. All the Theclinae except for *Calycopis* are placed in the catchall genus "*Thecla*". I doubt whether his treatment of *Calycopis* is accurate, and he apparently arbitrarily retains "*Thecla beon*". He uses *Eceres tulliola* for *Zizula cyna*, and *Hermiargus fileus* for *H. hanno* ssp. He also retains the palearctic genus *Scolitantides* for a number of species.

A careful critique of this work would bring out dozens of needed nomenclatural changes. One such interesting case is what Hayward calls *Anaea "cratias"*. This actually is an erroneous correction originally made by William P. Comstock in his generic revision for the much used "*crateis*". The correct specific name as published by Hewitson is *cratais*. Another long-standing error is the use of *Euptychia biocellata* Godman 1905, for *Euptychia imbrialis* (Weeks) 1901, due to an error in dating Weeks' taxa (1911 instead of 1901).

Because a complete synonymy is given on the family, subfamily, generic and subspecific levels, it seems strange to this reviewer to note the lack of synonymy at the specific level when the nominate subspecies is not part of the Argentine fauna.

Another serious error should be noted. As the author mentions in a footnote on page 12, many species based on Evans' "Santiago del Estero" in Bolivia have been included. Hayward somehow ignored the fact that there is a Santiago del Estero (sometimes "Estero") in the eastern part of the Bolivian department of Santa Cruz, near the Brazilian border. He, therefore, relegated these species to the Argentine province of Santiago del Estero.

The work is replete with typographical errors and omissions. The majority of these probably would have been corrected if Hayward had lived to see the work through the printing stage. These errors and omissions detract seriously from the scientific accuracy of the work. It is hopeful that the Instituto Miguel Lillo will publish a correction booklet.

Despite its many weaknesses this catalog is a must for the few active collectors in Argentina. For those who want to know what flies in Argentina it is the most up-to-date and accurate help available. It is amazing what Hayward accomplished, working nearly alone, devoid of easy access to the majority of the type specimens and to much of the literature.

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A BIBLIOGRAPHY OF THE CATALOGS, LISTS, FAUNAL AND OTHER PAPERS ON THE BUTTERFLIES OF NORTH AMERICA NORTH OF MEXICO ARRANGED BY STATE AND PROVINCE (LEPIDOPTERA: RHOPALOCERA), by William D. Field et al. Smithsonian Contributions to Zoology, no. 157. 104 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price: \$1.70 U.S.

This ambitious undertaking, said to have involved a great many years, is a veritable gold-mine of source papers, long overdue. It collects under one cover an astonishing wealth of references to ecological and zoogeographical information, often from obscure journals, although the authors confess that to prepare a definitive bibliography would take the rest of their lives. References to behavior, migration, life histories, foodplants, taxonomic notes, aberrations, local and regional lists, and distributional notes are included. A "Supplemental Bibliography" lists papers that embrace a number of states. In the words of its authors, "Bibliography is the handmaiden of all research. It is our hope that this bibliography will stimulate much future work on the fauna of North America."

OAKLEY SHIELDS, *Department of Entomology, University of California, Davis, California 95616.*

GENERAL NOTE

LEPIDOPTERA FEEDING AT STREAM MARGINS IN NEW ZEALAND

The phenomenon of butterflies and moths feeding at wet mud is well known in North America and the tropics (Downes 1973, J. Lepid. Soc. 27: 89-99). Mud feeding by butterflies has also been recorded from Europe (Stallwood 1973, Bull. Amat. Ent. Soc. 32: 64-72) and Australia (Common & Waterhouse 1972, Butterflies of Australia, Angus & Robertson, Sydney). There are no published records of Lepidoptera feeding from damp ground in New Zealand except for one record of *Bassaris gonerilla* (Fabricius) feeding from wet moss and liverworts beside a stream (Gaskin 1966, The Butterflies and Common Moths of New Zealand, Whitcombe & Tombs, Christchurch).

Observations in the summer of 1969-1970 and 1974 revealed that three out of the nine endemic New Zealand butterfly species feed at wet mud and sand beside streams. Males of *Argyrophenga antipodium* Doubleday, *Lycaena boldenarum* (White) and *Zizina oxleyi* (Felder) were often observed feeding at damp mud and sand beside streams at Woolshed Creek, Dunstan Mts., Central Otago, South Island (44°56' S, 169°42' E; 500-650 m). The feeding of male *L. boldenarum* and *Z. oxleyi* involved congregations of from 3-10 individuals in a space of about 20 cm². Male *A. antipodium* were observed feeding less frequently and then only singly or at the edge of the lycaenid concentrations. At Lake Taupo, in the North Island, huge swarms of *Zizina otis labradus* (Godart) have been observed feeding at damp mud and sand (G. W. Gibbs, pers. comm.). This species has been recorded feeding on moist soil in Australia (Common & Waterhouse, *op. cit.*).

On the summit of the Dunstan Mts. (44°53' S, 169°40' E; about 1700 m) males of the day flying geometrids *Dasyuris anceps* (Butler) and *Notoreas anthracias* (Meyrick) were observed drinking water from damp moss beside a mountain spring in December 1969. While water feeding is a well documented phenomenon for butterflies I believe this latter record to be the first observation of this type of supplementary feeding in diurnal temperate Geometridae.

Supplementary feeding at wet mud is usually found only amongst male Lepidoptera (Downes, *op. cit.*). The New Zealand species exhibiting this behaviour are no exceptions. Arms, Feeny and Lederhouse (1974, Science 185: 372-374) have shown that *Papilio glaucus* L. males are attracted by sand containing sodium salts and suggest that the need to acquire sodium ions, which are at low levels in many plants, is the major factor governing mud feeding. Downes (*op. cit.*) suggested that the greater flight activity of male Lepidoptera may necessitate higher nutrient levels. The essential role played by sodium in the neuromuscular system of herbivorous insects may thus explain the preponderance of male Lepidoptera in mud feeding congregations.

ROBIN C. CRAW, 15 Allen Tce., Linden, Wellington, New Zealand.

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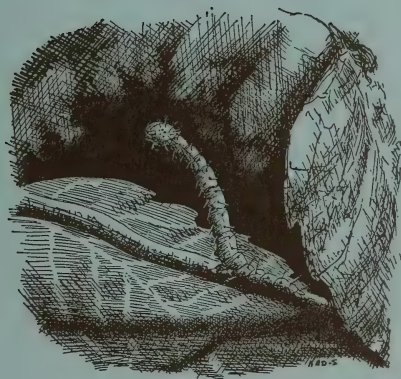
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Published quarterly by THE LEPIDOPTERISTS' SOCIETY

Publié par LA SOCIÉTÉ DES LÉPIDOPTÉRISTES

Herausgegeben von DER GESELLSCHAFT DER LEPIDOPTEROLOGEN

Publicado por LA SOCIEDAD DE LOS LEPIDOPTERISTAS



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by CYRIL F. DOS PASSOS

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JOURNAL OF THE LEPIDOPTERISTS' SOCIETY

Volume 29

1975

Number 4

WEST COLOMBIAN BIOGEOGRAPHY. NOTES ON *HELICONIUS* *HECALESIA* AND *H. SAPHO* (NYMPHALIDAE)

KEITH S. BROWN, JR.^{1,2} AND WOODRUFF W. BENSON^{1,2}

The western Cordillera of Colombia (Fig. 1) is a presently imperfect barrier for the dispersion of many butterflies which inhabit the tropical forests on its inner and outer (seaward) slopes. Several well-differentiated subspecies from the central valleys and the Pacific coastal regions of Colombia are known to meet locally and hybridize near lower passes (~1500 m) in the mountain chain between these warmer areas. Some of these, long considered as good species, have been able to overcome evolutionary barriers against interfertilization and form mixed populations. A good example of this is in the ithomiines *Hypothyris euclea caldasensis* Fox (Pacific slopes) and *H. e. philetaera* (Hewitson) (central valleys), which mix in various localities over a broad region from central Panamá south to Nariño in extreme southwestern Colombia, producing polymorphic populations which have given rise to at least four additional names, representing recombinants of the two parent color-patterns ("micheneri" Fox, "nemea" (Weymer), and "bifasciata" (Neustetter) \equiv "neustetteri" Real) (cf. Fox & Real, 1971). A much more restricted mixing takes place between *Heliconius clysonymus clysonymus* Latreille (central valleys) and *H. c. hygiana* (Hewitson) (western Ecuador), which meet in sparse populations near Queremal and Lago Calima, west of Cali, Colombia, forming unusual polymorphic populations with recently described forms (Holzinger & Holzinger, 1970; Brown & Mielke, 1972). *Heliconius cydno weymeri* Staudinger ranges from the upper Cauca Valley into these same areas and the Dagua

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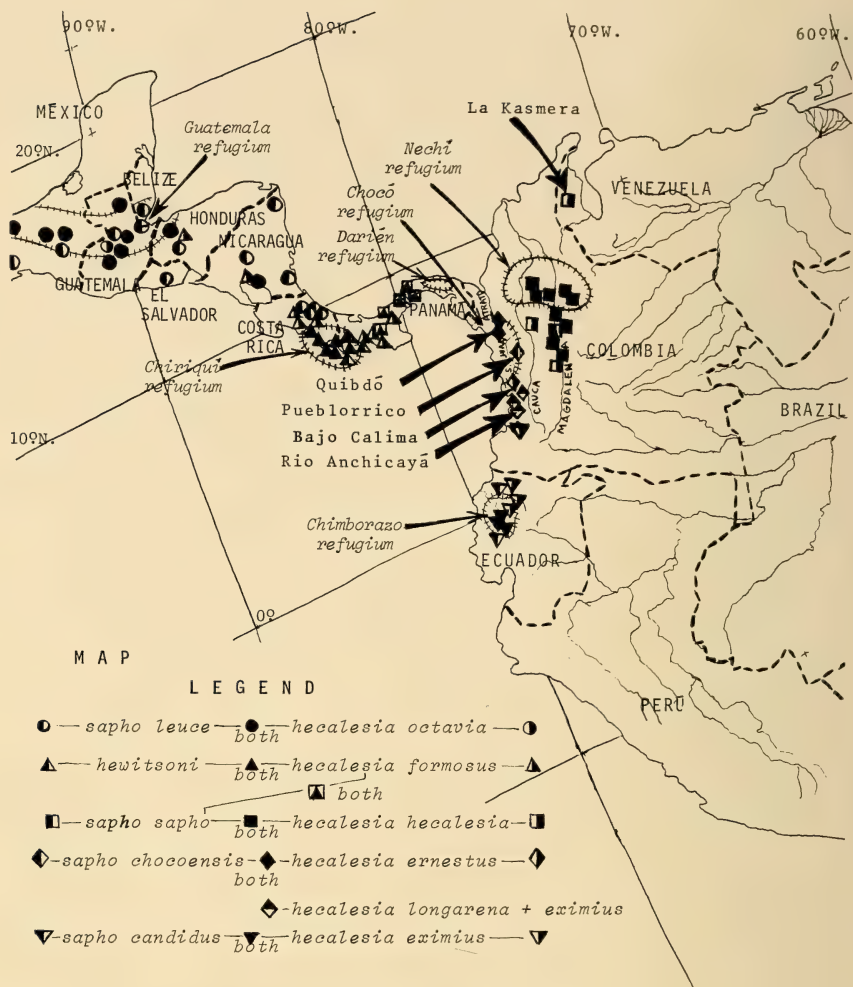


Fig. 1. Distribution map of *Heliconius* species.

River Valley, meeting *H. c. zelinde* Butler from the Pacific slopes and *H. c. cydnides* Staudinger from the upper parts of the western Cordillera and forming spectacularly polymorphic populations (Holzinger & Holzinger, 1968; Brown & Mielke, 1972). *Heliconius eleuchia eleuchia* (Hewitson) also gets across the western Cordillera from the Cauca Valley near Cali and occasionally hybridizes with its Pacific subspecies *H. e. eleusinus* Staudinger in the Anchicayá Valley, giving the named form "ceres" Oberthür (Brown & Mielke, 1972; Brown, 1975).



Figs. 2-5. *Heliconius hecalesia*. 2, *H. h. octavia*, male, Panajabel, Chimaltenango, Guatemala (AMNH). 3, *H. h. octavia*, female, Yepocapa, Guatemala (AMNH). 4, *H. h. formosus*, male, Costa Rica? (labelled "Tamahu, Alta Verapaz, Guatemala" but identical to specimens from Costa Rica and Panamá) (AMNH). 5, *H. h. hecalesia*, male, La Kasmera, Sierra Perijá, western Venezuela (Facultad de Agronomía, Maracay). All butterflies ca. $0.70 \times$ life size; black, red-orange or buff and yellow.

Heliconius hecalesia (Hewitson)

Systematics. *Heliconius hecalesia* (Hewitson) and *H. longarena* (Hewitson), a further closely related, allopatric and morphologically differentiated pair of species (Emsley, 1965), might be predicted to meet somewhere in the western part of Colombia and either intergrade or occur sympatrically, depending upon the degree of reproductive isolation associated with their geographic separation and morphological differences. Both are strong flyers that occur from near sea level to over 1500 m altitude and could easily fly over low passes in the western Cordillera. Unfortunately, both are also very local, rare and unusually difficult to locate. Capture of specimens is frequently impossible even when a good colony is discovered, as stops at flowers are very rare and the individuals fly high in near-inaccessible thick forest (even sure identification or analysis of color pattern is thus difficult). Because of these habits of *H. hecalesia* and *H. longarena*, the total number of specimens known, especially for the latter, is very small, and no clear intermediates have been found.

The named subspecies of the two species are few. *H. hecalesia octavia* Bates (Figs. 2-3) is known from southern México to Nicaragua. It is sexually dimorphic, the black and orange male (Fig. 2) converging on



Figs. 6-13. *Heliconius* spp. 6, *H. hecalesia hecalesia* varieties, Colombia: upper left (male), Barranca Bermeja; upper right (male), Bassler's "NE Peru" label = Magdalena Valley, Colombia; lower left (male), Quebrada La Lechera, Rio Opon Region, Quindio; lower right (female), Quebrada La Borrascosa, same region. Note wide variation in hindwing markings (AMNH). 7, *H. h. gynaesia*, HOLOTYPE, male, "Colombia"?, BM(NH). 8, *H. godmani*, male, in nature, Quibdó, Chocó, Colombia,

Tithorea tarricina duenna Bates, and the light buff-streaked female (Fig. 3) on *Dircenna klugi* (Geyer) (both are common ithomiines in the same region). This phenomenon has only been verified for two other, also very rare species of *Heliconius*: *H. nattereri* C. & R. Felder (Brown, 1970, 1972) and *H. demeter* Staudinger (Brown & Benson, 1975). *H. hecalesia formosus* Bates (Fig. 4) is found in Costa Rica and Panamá; its dark forewing makes it a good member of the common local mimetic group headed up by *Tithorea tarricina pinthias* Godman & Salvin, *Mechanitis polymnia isthmia* Bates (for an explanation of this combination, see Brown, 1976), and *Heliconius hecale zuleika* (Hewitson), though *H. hecalesia formosus* occurs well south of the limits of the latter. From western Venezuela (Brown & Fernández Yépez, in prep.) (Fig. 5) through the Magdalena and lower Cauca valleys of Colombia is found the strikingly patterned *H. hecalesia hecalesia* (Hewitson), converging in color pattern on many local ithomiines such as *Tithorea tarricina tarricina* Hewitson (form "hecalesina" C. & R. Felder) and *Callithomia hezia tridactyla* Hewitson; appreciable variation in size and color of the hindwing markings is known both in *H. h. hecalesia* and its mimics (Fig. 6). A single specimen of unknown collecting locality, *H. h. gynaesia* (Hewitson) (Fig. 7) is so close in color pattern to the endemic Chocó *Heliconius godmani* Staudinger (Fig. 8) and other sympatric ithomiines, that it might be presumed to inhabit the northern Chocó, on the Pacific slope of Colombia. In the southern Chocó is found *H. longarena* (Hewitson) (Fig. 9) with a divided series of postmedian spots and a broad orange mark in the basal area of the forewing. A unique aberration of this entity, lacking all the distal yellow marking on the fore- and hindwings, was captured in the Anchicayá Valley by Leoncito Denhez and sent to H. Gerstner in Germany; its present resting place is unknown. From the Calima and Anchicayá areas southward, generally at moderate elevations, occurs the normal pattern of *longarena* with a broad yellow postmedian band on the forewing, named *eximius* by Stichel in 1923 (Fig. 10). The southern limit presently known for the species in western Ecuador

←

January 1972. 9, *H. hecalesia longarena*, HOLOTYPE, male, N. Granada, BM(NH). 10, *H. h. eximius*, male, Rio Palenque Biological Station, near Quevedo, west Ecuador (Allyn Museum of Entomology, Randy Dodson leg.). 11, *H. h. ernestus* nov., HOLOTYPE, male, dorsal (right) and ventral (left) surfaces, Quibdó, BM(NH). 12, *H. h. ernestus* nov., HOLOTYPE, natural pose, shortly after emergence. 13, *H. h. ernestus* nov., PARATYPE, male, Bajo Calima, Valle, Colombia, August 12, 1973, M. Takahashi coll., $0.33 \times$ life size. All butterflies (except as noted) ca. $0.70 \times$ life size; black, yellow and orange.

is Los Rios Province (Rio Palenque Biological Station of the University of Miami, halfway between Santo Domingo and Quevedo).

Field work. The authors first visited Quibdó, in the northern Chocó of Colombia, west of Medellin on the upper Rio Atrato, in the week of 15–21 January 1972. In spite of the high rainfall known for the area (over 10,000 mm per year in the city, the greatest amount known in the world, and unknown but probably appreciably greater amounts in the forested areas farther up the slopes of the Cordillera), most days included several hours of brighter weather, and field work was very productive, especially for little-known endemic forms. On 16 January we were examining a large *Passiflora* (*Tryphostemmatoides*) *gracillima* vine draped over a fence just southeast of Quibdó (Km 2.7 on the road to Itsmina), when we discovered two very strange-looking larvae. They were dirty yellow-green in ground color, with black heads and underparts and a black spot-pattern very similar to most common *Heliconius* larvae (*H. erato* (L.), *H. melpomene* (L.), *H. numata* (Cramer), etc.). Both were in the fifth instar and rapidly completed growth on the same plant, pupating a few days later. The pupa was no less unusual than the larvae, sharing with the pupa of *H. xanthocles* Bates the character of foliaceous projections on the latter abdominal segments (Turner, 1968); it could be rationalized, however, as a streamlined, rather modified version of an *H. erato* chrysalis (Beebe, et al., 1960).

One of the pupae survived, developing into a near perfect adult (lacking one antenna) two weeks later. This specimen (Figs. 11, 12) represented an unknown subspecies of *Heliconius hecalesia* or *H. longarena*, and was indeed transitional between the two, suggesting that they might be but one species. No further larvae were found in later trips to Quibdó, though the vine was still intact and heavily infested with larvae of *Dryas iulia* (F.). No adult *Heliconius hecalesia* were observed flying in the area or in nearby woods, roads and hilltops (the promenading behavior of *H. h. formosus* males in Panamá would suggest a territorial division of ridge, path or hilltop areas).

Since 1972, two additional specimens of this same pattern have been captured: a female was taken near Quibdó, and a male was collected in the lower Rio Calima area, both by Mayuma Takahashi. This new entity apparently represents an undescribed endemic Chocó subspecies of *Heliconius hecalesia*. The unique *H. gynaesia* would then be a transitional form to *H. h. hecalesia*, with fused (not doubled) postmedian elements (note *gynaesia*-like *h. hecalesia* in Fig. 5). The taxon *longarena*, which may still be captured in a limited area west of Cali, would be a transition to *eximius*, possessing an orange cubital bar on the forewing

but still a broken series of yellow spots. A description of this new subspecies is thus presented here.

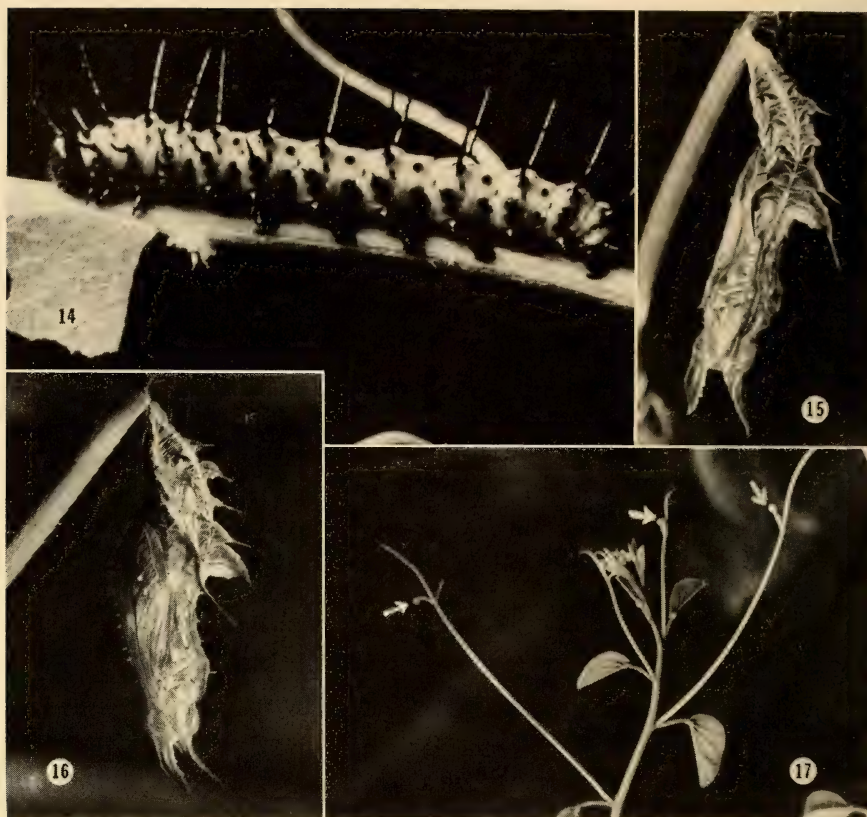
***Heliconius hecalesia ernestus* K. Brown and Benson, new subspecies**
(Figs. 11–13)

Male: FW 40 mm. Very similar dorsally to *Heliconius longarena* (Fig. 9), but lacking the bright orange bar over forewing cubitus, base of forewing entirely black; additional yellow spot present in middle of forewing space Cu1–Cu2; hindwing basal orange patch larger, extending distad at veins Cu2 and 2A to meet doubled yellow intervenal submarginal streaks. Similar also to *H. h. gynaesia*, but with all series of postmedian (or submarginal) streaks doubled; forewing yellow markings slightly reduced in area; hindwing orange patch more extensive. Ventral surface essentially identical, with orange costal line margined with yellow on forewing and yellow costal streak fading to orange on hindwing; no red basal spots.

Types. HOLOTYPE: ♂, Quibdó, Chocó, Colombia, reared from larva found on *Passiflora gracillima* vine at Km 2.7 of road to Itsmina, overlooking Rio Atrato SE of city, emerged in Manaus (Amazonas, Brazil) on 4 February 1972, lacking left antenna. Donated by the authors to the British Museum (Natural History). PARATYPES: one ♂, lower Rio Calima (near lower Rio San Juan), 12 August 1973; one ♀, Rio Guayabal, Quibdó, 2 September 1973; both in the collection of M. Takahashi, Shizuoka, Japan.

This subspecies is dedicated to Dr. Ernesto W. Schmidt-Mumm of Bogotá, in gratitude for his many favors, encouragement, hospitality, and specimens of and information about Colombian *Heliconiini*.

The existence of this color pattern in the north central and in low elevation southern Chocó implies that *hecalesia* and *longarena*, like other related *Heliconius* "species-pairs" separated by the western Cordillera of Colombia, have managed to meet and mix, being best regarded as a single species with *hecalesia* taking name priority. The male paratype, from the south, has a more reduced orange basal area on the hindwing and no yellow cubital spot on the forewing (Fig. 13), which would be expected from its proximity to the *longarena/eximius* mixed populations in the higher parts of the extreme southern Chocó (Alto Rio Calima). The new subspecies is expected to occur sparsely at low or moderate elevations in the western part of Colombia between Quibdó and Buenaventura. The older Hewitson names, both probably transitions from *H. h. ernestus* to the adjacent subspecies, are nonetheless maintained for the time being. They may be applied to the respective phenotypes, even though they possibly do not represent good geographical subspecies. Pure populations of *H. h. longarena* are not known, but the entity is not rare in west central Colombia near Buenaventura at high elevations. Pure populations of *H. h. gynaesia* may someday be found in the extreme northern Chocó, or some part of the Cauca Valley.



Figs. 14–17. *Heliconius hecalesia ernestus* and hostplant. 14, fifth instar larva, Quibdó, Chocó, Colombia, $2\times$ life size, greenish-yellow and black. 15–16, pupa, $1.6\times$ life size, silvery gray. 17, meristem of hostplant (*Passiflora gracillima*) with egg mimics (arrows), Quibdó, Km 2.7 of road to Itsmina, January 1972.

Partial biological information on the new subspecies, *H. h. ernestus*, is also presented here:

Fifth instar larva (Fig. 14). Dark greenish-yellow with black head, legs, scoli, prothoracic plate, prolegs, and anal segment; spot patterned as in *H. erato* larvae. Head scoli $1.0\times$, dorsal scoli up to $1.3\times$ head height. Mature length about 38 mm. Feeds on *Passiflora gracillima*. Two larvae were found on a single meristem, indicating larval tolerance and possible batch-style oviposition by the female, with larvae semi-gregarious in the early stages and tolerant of others even when large.

Pupa (Figs. 15, 16). Gray, highly sculptured and patterned with fine black and white lines. Reflective patches dorsally on 3TH, 1AB and 2AB. Paired dorsolateral flanges on 3AB (large, directed cephalad), 4AB (smaller, parallel with others), 5AB (very small), 6AB (\cong 4AB) and 7AB (small), each armed with moderately long spine (that on 3AB considerably longer than others). Short spines, arising from

tubercles, also present on 2TH, 3TH, 1AB and 2AB. Tubercles on wing cases in future cells M3-Cu1 and Cu1-Cu2. Antennal cases (on costal margin of forewings) armed with many short spines. Eyes large and prominent. Long, broad, pointed and very slightly serrate paired head appendages. Length about 29 mm; duration 15 days (eight of these at about 18°C, in Bogotá).

The larval foodplant of *Heliconius hecalesia* (*Passiflora gracillima*) shows a most unusual method of probable protection against excessive meristem depredation by *Heliconius* larvae, through egg mimicry (Ben-son, et al., 1975). The trifid tendrils on meristems develop lateral super-numerary flower buds, which grow rapidly to the size of 1 mm, cease development, and later drop off; these are yellow in color, and their size and shape make them very similar to most *Heliconius* eggs (Fig. 17). It is well known than many species of *Heliconius* assess egg and caterpillar loads in order to avoid multiple oviposition on a single food-plant meristem, because many of the caterpillars are intolerant and even cannibalistic. The best known of these species is *H. erato*, which is frequent in the Chocó. We have found early stages of *H. erato venus* Staudinger on small plants of *P. gracillima* in the Quibdó area. The first author watched an *erato* female inspect carefully and then leave meristems of the Itsmina road *P. gracillima* vine on 17 June 1973 without ovipositing. It is possible that this large plant's abundant fake "eggs" discouraged her. Other *Passiflora* species are known to produce egg mimics as yellow leaf glands and stipule tips, and these may be significant armaments of protection against loss of new vegetative growth to larvae of the physiologically specialized, visually orienting heliconians.

The fact that the *H. hecalesia* larvae in Quibdó were found on a plant bearing abundant egg mimics further supports the hypothesis that *H. hecalesia* uses multiple oviposition and has tolerant larvae because the female apparently did not mind the presence of abundant fake "eggs" on the meristem chosen for an ovipositional site.

However, the use of the *H. hecalesia* foodplant by the solitary and aggressive larvae of *H. erato* (even if often discouraged by egg mimics), suggests that competition may have been an important factor promoting a preference for heavily forested habitats (rarely penetrated by *H. erato*) in *H. hecalesia*, and maintaining its rarity in the present day. A detailed study of possible competition between these two species, prejudicial to *H. hecalesia*, would be easily undertaken in some parts of Panamá or southeastern Costa Rica, where *H. h. formosus* is not uncommon. This would help define the basis for the very large behavioral differences and disparity in abundance between these two systematically very closely related species.

Heliconius sapho Drury

Systematics. The distribution of the subspecies of *Heliconius sapho* Drury, one of the most evolved species in the genus (Emsley, 1965; Brown & Mielke, 1972), would be closely analogous to the pattern of *H. hecalesia* subspecies, were *H. sapho* known from western Colombia. Indeed, the theory of heliconian differentiation in Quaternary forest refugia (Brown, et al., 1974; Brown, 1975) would suggest that similar processes and areas were acting in the evolution and subspeciation of the two species, independent of their geological ages or color patterns.

H. sapho leuce Doubleday occurs in the same area (México to Costa Rica) as *H. hecalesia octavia*. Both presumably evolved in the Guatemala refugium ("Central American Rain Forest"). A splinter species closely related to *H. sapho* (but definitely not conspecific), *H. hewitsoni* Staudinger, probably differentiated along with *H. hecalesia formosus* in isolation in the Chiriquí refugium. The Colombian *H. s. sapho* Drury like *H. h. hecalesia* probably evolved in the Nechí refugium. Like many such entities, it occurs today as far north as central Panamá (where it is barely sympatric with *H. h. formosus* which has spread southward farther than most Chiriquí taxa). The range of *H. hecalesia eximius* in western Ecuador (Chimborazo refugium) is shared by the recently described *H. sapho candidus* Brown which, however, is not known from southwestern Colombia as is *H. h. eximius*. This leaves a fairly large discontinuity in the distribution of *H. sapho*, from the northern Chocó down the coast and in the Cauca Valley, as far south as Nariño. The closest approximation of the superficially similar *H. s. sapho* and *H. s. candidus* is the middle Magdalena Valley in Colombia and Paramba in northwestern Ecuador, some 700 km apart. The recognition of this discontinuity might suggest the existence of a *H. sapho* subspecies in western Colombia, perhaps very rare or even extinct today, but historically predictable as a link in the once continuous distribution pattern of the species. From consideration of the observed close mimetic parallelism of *H. sapho* forms with *H. cydno* subspecies, this hitherto unknown subspecies would be predicted to be blue-black with a single broad white forewing band, much like the endemic west Colombian *H. cydno zelinde* and also the closely related, endemic Chocó *H. eleuchia eleusinus* (formerly placed with *H. sapho*).

Field Work. This predicted but previously undiscovered subspecies of *Heliconius sapho* was encountered by the authors near Quibdó. At Km 204 of the Medellín-Quibdó highway (10 km E of the police check point), a trail into the woods led to a ridge where *H. cydno zelinde* was flying commonly along with a most unusual and mixed population

of *H. sapho*. This consisted of a small number (one of the eleven caught, another seen) of typical central valley *H. s. sapho*, a variety of transitional forms (five captured) with reduced white scaling on the hindwing margin and a majority (five captured, with many more seen) of the expected pattern closely resembling *H. cydno zelinde* with a fully dark hindwing (Fig. 18). As the last form was not present in a pure population, it could not be named, but it was hoped that it could be found pure farther south, in the central Chocó.

A long series of heliconians in the American Museum of Natural History from Itaburi, Pueblorrico on the Pacific slopes of Risaralda Province (formerly part of Caldas), about 80 km SE of Quibdó (Fig. 1), includes many *Heliconius cydno zelinde* (Fig. 19), a number of both white and yellow-banded forms of the similar *H. eleuchia eleusinus* (Fig. 20), and two specimens of the *zelinde*-like *sapho* subspecies. As they may be presumed to come from a pure population, these two are here designated as types of a new subspecies.

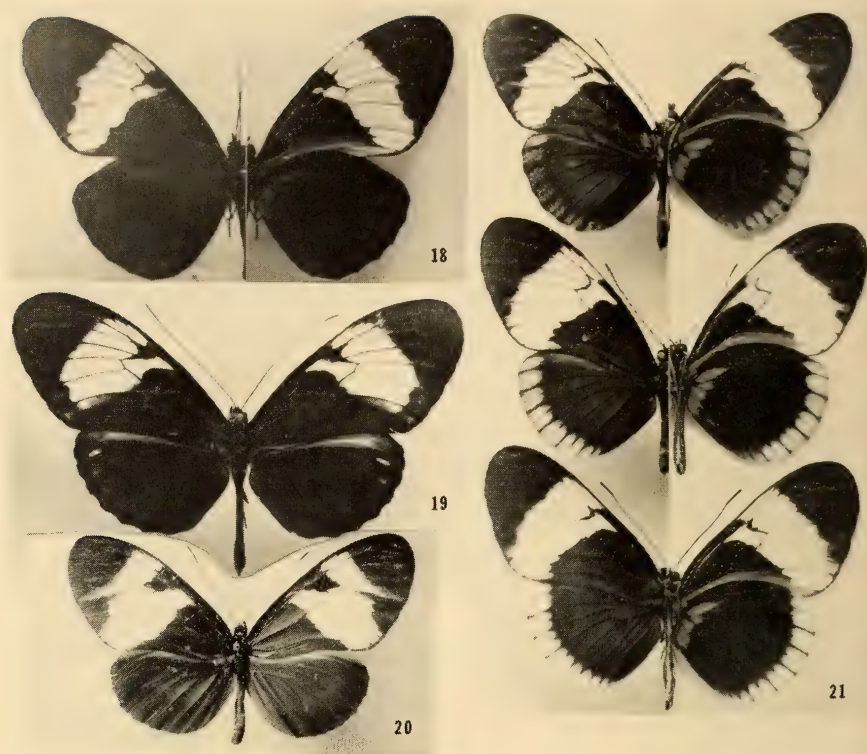
***Heliconius sapho chocoensis* K. Brown and Benson, new subspecies**
(Fig. 18)

Male. Very similar to the nominate subspecies, but almost entirely lacking white scaling in hindwing border. Forewing dorsally blue-black, divided by broad white postmedian band, crossed by black veins and incised costally at apex of cell to base of vein M3 (leaving a variable element within the cell), slightly tapered anally, conically expanded distally along vein M3. Hindwing dorsally blue-black with very scattered white scales in marginal area. Ventrally similar, black with identical white forewing band, short red costal lines on both wings and five large red basal spots on hindwing which bears almost imperceptible white scaling in submarginal region.

Types. Holotype and paratype in the American Museum of Natural History from Itaburi, "Pueblo Rico," "Caldas" (now Risaralda), Colombia, 1000 m, (5°12' N, 76°8' W), January 1946.

A number of similar males and females, not designated as paratypes, were captured in a polymorphic population (Fig. 21) in ridge forest to the south of Km 204, Medellin-Quibdó highway, Chocó, Colombia in January 1972 and June 1973. Most were found either promenading over the ridge or feeding on low white flowers of a cucurbit vine in the early morning. A further polymorphic population of *H. sapho* like that in Fig. 21 was found recently near Cabo Corrientes on the coast west of Quibdó.

The mixed character of the Quibdó *H. sapho* population suggests that some Nechí-refugium forms from the Magdalena and lower (northern) Cauca valleys may be able to cross the western Cordillera either along the Medellin-Quibdó highway (maximum elev. ca. 2000 m) or around the northern spurs of the Cordillera at lower altitudes (perhaps diffusing



Figs. 18–21. *Heliconius* spp. 18, *H. sapho chocoensis* nov., HOLOTYPE, male, Itaburi, Pueblorrico, Risaralda, Colombia, 1000 m, January 1946 (AMNH). 19, *H. cydno zelinde*, Quibdó, Chocó, Colombia, January 1972. 20, *H. eleuchia eleusinus*, Quibdó. 21, Three specimens of *H. sapho* from a mixed population *sapho* × *chocoensis*, Quibdó (Km 204 of highway from Medellín), January 1972. All butterflies ca. 0.70 × life size; blue-black and white with red ventral spots.

south from the Darien area) to meet Chocó forms along the Rio Atrato. That this is indeed possible is supported by the capture of occasional *Heliconius erato* of the *hydara* (Hewitson)-type, with no ventral yellow hindwing bar and reduced or no blue iridescence, in the *H. e. venus* populations near Quibdó, and of *H. cydno* of the *chioneus* Bates type, with a white hindwing border like *H. s. sapho* (occurring in the Nechí area today together with resident *H. c. cydno* (Double-day), but probably derived from a Darien refugium), in the *H. c. zelinde* populations of the area. Interestingly, however, the *H. eleuchia* of the area occur only as *eleusinus*, even though the two subspecies do meet west of Cali in the Anchicayá Valley far south of Quibdó.

Apparently *H. eleuchia* invades and moves west from the upper Cauca Valley (as does *H. clysonymus*), not inhabited by *H. sapho*, while the latter species moves west from its center in the northern Magdalena and reaches the west coast by a northerly route. The difference is probably related to behavioral or habitat preferences, *H. sapho* preferring lower and less folded terrain and *H. eleuchia* preferring hilly areas. *Hypothyris euclea philetaera* and *Heliconius hecalesia* and *H. cydno*, having more cosmopolitan habitat acceptance, probably follow both these routes of invasion and several more also, in the case of *H. cydno* as two different subspecies.

The distributions of the known subspecies of *H. hecalesia* and *H. sapho* are illustrated in Fig. 1.

It may be predicted that many further new subspecies and missing zoogeographic links will be found in the Chocó, which is a refugium in its own right; a number of these have already been seen in the Ithomiinae.

ACKNOWLEDGMENTS

We are grateful to the Trustees of the British Museum (Natural History) and R. I. Vane-Wright, P. R. Ackery and R. L. Smiles of the Entomology Division of the same; to the American Museum of Natural History (F. H. Rindge, Curator of Lepidoptera); and to the Museu Nacional in Rio de Janeiro (A. R. do Rêgo Barros) for access to collections and information. Assistance in field work and much data were provided by Dr. E. W. Schmidt-Mumm of Bogotá and Leoncito Denhez of Cali, to whom we are deeply indebted. Photographic enlargements were prepared by Jorge H. Leão. Financial support of work on insect ecology is acknowledged, from the Conselho Nacional de Pesquisas, the Banco Nacional do Desenvolvimento Econômico (FUNTEC 47 and 101), the Ministerio do Planejamento (contract 140/CT, FINEP/FNDCT), and the Conselho de Pesquisas e Ensino para Graduados of the U. F. R. J.

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PYRGUS XANTHUS (HESPERIIDAE): SYSTEMATICS,
FOODPLANTS AND BEHAVIOR

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Pyrgus xanthus Edwards has been greatly confused with *P. scriptura* (Boisduval) and *P. ruralis* (Boisduval) (Brown et al., 1957; Callaghan & Tidwell, 1972). This paper clarifies the systematic position of *xanthus*, details its distribution especially in Colorado, and presents brief observations on foodplants, habitat, and adult behavior. I thank F. M. Brown for providing photographs of the types of *xanthus*, and Scott L. Ellis, C. Don MacNeill, Kilian Roever, Maurice Howard, Glenn R. Scott, Ray E. Stanford, and Samuel Johnson for providing specimens and helpful information.

Systematic relationship. Table 1 and Figs. 1–30 show 35 characters by which one or more of the above three species differs from the others. Genitalic characters are based on 10 individuals of each sex of each species. *P. xanthus* is clearly very closely related to *P. ruralis* and much different from *P. scriptura*. *P. xanthus* and *P. ruralis* are apparently completely allopatric, so that *xanthus* is the allopatric representative of *ruralis* characterized by the lack of a costal fold and several genitalic and wing pattern characteristics. It seems best at this time to regard *xanthus* and *ruralis* as distinct species because of these differences in morphology, and because the costal fold of *ruralis* possibly emits a pheromone enabling reproductive isolation from *xanthus*. Further sampling at possible areas of sympatry (they come within about 10 miles of each other in the Douglas-Jefferson Counties area, Colorado) may resolve this question.

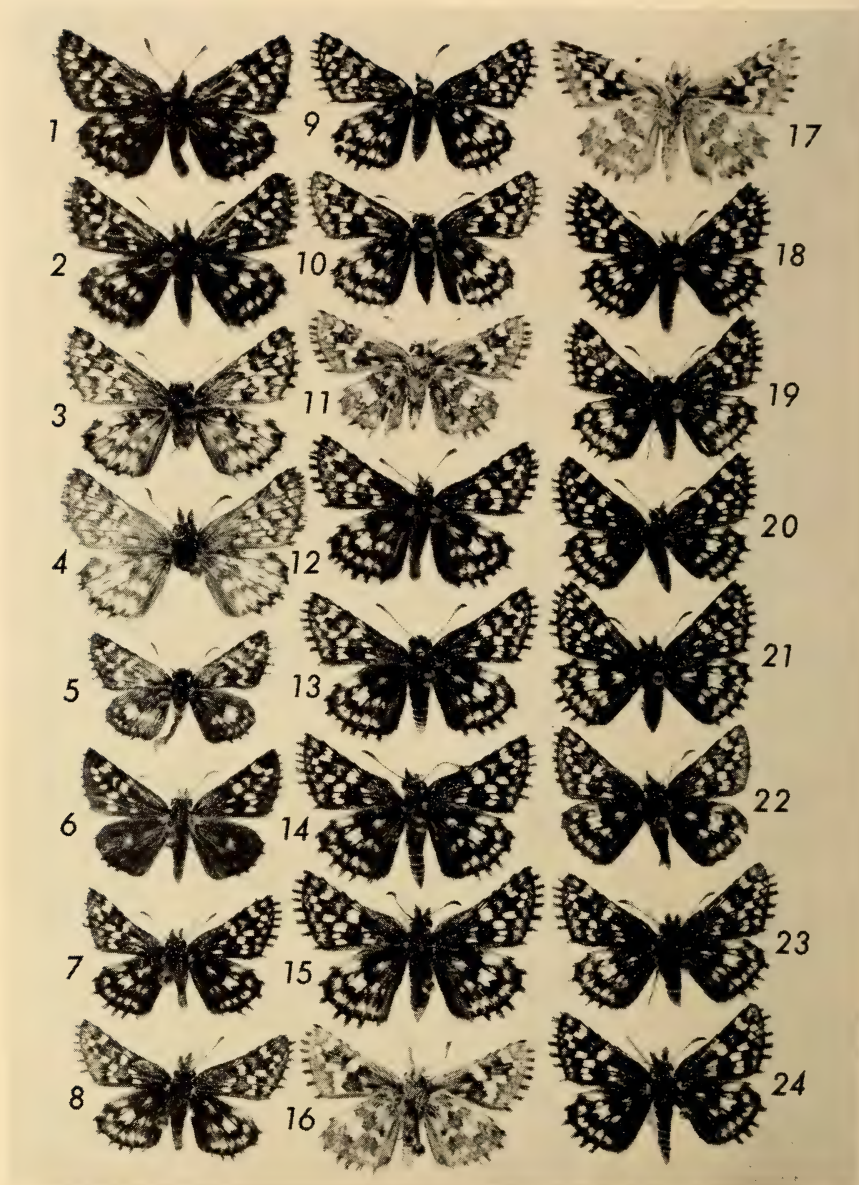
The spring brood of *P. scriptura* has larger white wing spots than later broods (Fig. 5), and was misidentified and figured as *xanthus* by Brown et al. (1957). Spring brood *scriptura* are similar to later broods (cf. Table 1) except for several wing pattern characters by which they can be distinguished. I have seen one *scriptura* from southern Nevada in August with large white wing spots (coll. Ralph Wells), and rarely *xanthus* lacks the basal dorsal hindwing spot, but usually the two species can be easily separated by wing pattern. A whitish subspecies of *P. ruralis* from San Diego County, California (Figs. 3–4) has sometimes been called *xanthus*, but it is identical to *ruralis* in all the characters listed in Table 1. The only geographic variation in *xanthus* appears to

TABLE 1. Differences between *Purgus scriptura*, *P. ruralis*, and *P. xanthus*.

Character	<i>scriptura</i>	<i>ruralis</i>	<i>xanthus</i>
altitude	4500-8400' in Colo.	6200-10500' in Colo.	8500-10500' in Colo.
habitat	prairie	openings in coniferous forest	openings in aspen-coniferous forest
foodplant	Malvaceae: <i>Sida hederacea</i>	Rosaceae: <i>Potentilla</i> spp.	Rosaceae: <i>Potentilla</i> spp.
number of broods	three (April-May, June-July, August-Sept)	one (March-June)	one (May-June)
male costal fold	absent	present, small	absent
white spot, base of DHW	absent	almost always present	present
fringe HW	black spots extend only half of fringe	black spots extend to edge	black spots extend to edge
ground color of VHW	greyish tan	reddish tan when fresh	reddish tan when fresh
medial spots VHW	less strongly outlined, less contrasting with ground color	strongly outlined & contrasting with ground color	strongly outlined, highly contrasting with ground color
marginal crescentic spots VHW	crests in cells Cu ₁ & Cu ₂ little longer than those anterior, crescents distinct to margin	crests in cells Cu ₁ & Cu ₂ slightly longer than those anterior; spot in cell Rs longer than in other species, cell M ₁ -M ₃ spot suffused with white, which divides marginal ground color band; this band obscures crescents less than in <i>xanthus</i>	crests in cells Cu ₁ and Cu ₂ longer than those anterior, crescents obliterated by ground color distally except in cell Cu ₂
tegumen	triangular in dorsal and ventral view	oval in dorsal view, bent downward anteriorly in lateral view	oval in dorsal and usually in lateral view
uncus	narrow, sinuous, hooked	narrow, evenly curved	wider, evenly curved
sclerite at base of uncus	long	short	short

TABLE 1. (Continued)

Character	<i>scriptura</i>	<i>ruralis</i>	<i>xanthus</i>
gnathos	absent beyond gnathal bridge	strongly curving to a point beyond gnathal bridge	weakly curving to a point beyond gnathal bridge
sacculus	longer	short, broadly connected to vinculum	short
juxta	roughly quadrate, with a dorsal flange extending posteriorly	U-shaped with a shallow notch, no flange	heart-shaped, no flange
acedeagus	bent near middle, slightly bent near base	bent near distal end, spoon-shaped basally	bent near distal end, otherwise nearly straight
valva	long; prong attached dorsally & directed ventroposteriorly with many recurved spines on bulbous tip; A & B narrow, B curved dorsally	shorter; prong attached ventrally, with oval base and a row of long spines at end, directed anteroventrally; A & B wide, B not curved dorsally	shortest especially dorsally; prong as in <i>ruralis</i> but with shorter spines; A wide, B very wide, B not curved dorsally
pre-ostial membrane	no pouch	with a ventral pouch	no pouch
ostium bursa	at anterior edge of lamella postvaginalis	anterior to lamella	anterior to lamella
ductus bursa	with oval sclerite near ostium	no sclerite	no sclerite
lamella postvaginalis (shape somewhat variable)	two separate sclerites (rarely connected by weakly sclerotized area), each narrowing laterally terminating in a "foot"	one sclerite, V-shaped (narrowed near ostium) and usually with two small anterior arms	one sclerite of two rectangular parts narrowly connected anteriorly
lateral pre-papillar sclerites (tergum 8?)			
a. shape (somewhat variable)	with a falcate ventral neck	roughly quadrate-hexagonal, larger than other two spp.	roughly quadrate-hexagonal
b. anterior tooth	very small to almost absent, no neck	small, at end of neck	long, no neck



Figs. 1-24. Adults of *Pyrgus* spp. *P. ruralis*: 1, ♂, Coal Creek, Jefferson Co., Colorado; 2, ♀, Gregory Canyon, Boulder Co., Colorado; 3, ♂ and 4, ♀, Laguna Mts., San Diego Co., California. *P. scriptura*: 5, ♂ (spring form), Scottsbluff, Nebraska; 6, ♀, nr. Westcliffe, Custer Co., Colorado. *P. xanthus*: 7, ♂, Raton Mesa, Colfax Co., New Mexico; 8, ♂, nr. Game Ridge, Custer Co., Colorado; 9, ♀, Saguache Park, Saguache Co., Colorado; 10, ♀, and 11, ♂, Devil's Hole, Huerfano

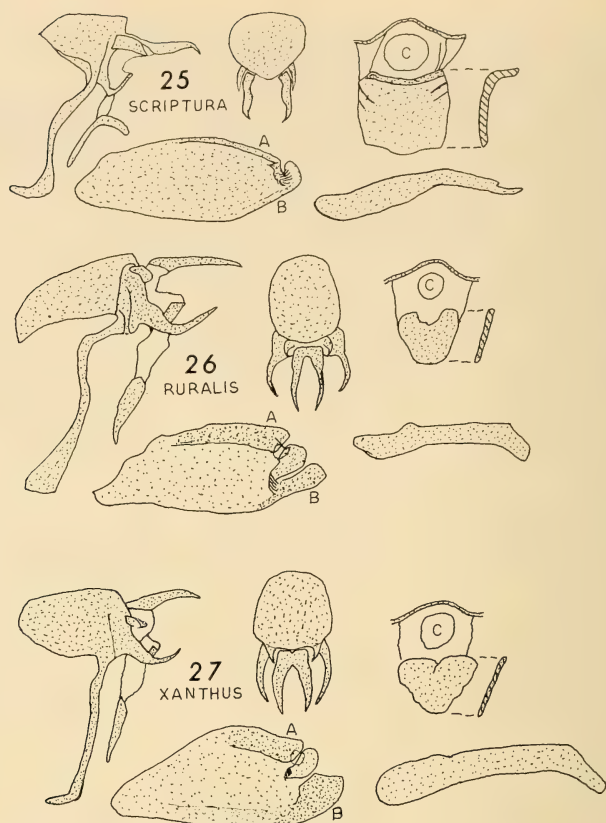
be a slight increase in size in the southern part of its range. The name *macdunnoughi* (Oberthür) is a synonym of *xanthus*.

Lectotype and type-locality. W. H. Edwards (1878) described *P. xanthus* based on several specimens labeled "southern Colorado" collected by Morrison. The Carnegie Museum of Natural History has three male and two female syntypes, and the American Museum has one syntype. F. M. Brown will designate a lectotype male *xanthus* in the Carnegie Museum. I examined photographs of the lectotype and a female paralectotype taken by Brown; both specimens possess all the wing characters described for *P. xanthus* in Table 1. I designate the vicinity of Rosita, Custer County, Colorado, as type-locality of *xanthus*, because Morrison may have collected there (F. M. Brown, pers. comm.) and the species occurs there.

Foodplants. The foodplants of *Pyrgus* (and relatives *Spialia* and *Muschampsia*) are primarily Rosaceae (*Potentilla*, *Rubus*, etc.) and Malvaceae, and several species even feed on both families (Higgins & Riley, 1970). *Pyrgus scriptura* feeds on *Sida hederacea* (Malvaceae; many larvae were reared to adults by Jerry A. Powell and C. Don MacNeill at Pittsburgh, California) and *Sphaeralcea coccinea* (Malvaceae; ovipositions at Green Mountain, Jefferson County, Colorado). *P. ruralis* larvae were found feeding on leaves of several *Potentilla* spp. in California by C. Don MacNeill (pers. comm.). *P. ruralis* "feed on the tender centers of *Potentilla tenuiloba*" (Comstock, 1927), and may use *Potentilla* (*Horkelia*) *bolanderi* in southern California (Emmel & Emmel, 1973). Lambert (1894) observed oviposition of *ruralis* in the center of *Potentilla* (*Horkelia*) *fusca* plants. Tietz (1972) lists *Potentilla douglasii* as a foodplant for *ruralis*, which is a synonym of *P. (H.) fusca*. Both Tietz (1972) and Garth (1935) list *Sidalcea* (Malvaceae) for *ruralis* but give no documentation. *Sidalcea* must be considered erroneous for *ruralis*, or based on misidentified animals, until proven otherwise. *P. xanthus*, like *P. ruralis*, seems to feed on *Potentilla* exclusively, and Malvaceae do not occur in most *xanthus* habitats. Female *xanthus* oviposited in the center of *Potentilla* sp. flowers near Flagstaff, Arizona (Kilian Roever, pers. comm.), are associated with *P. ambigens* (determined by William Weber, who doubts the status of *ambigens* as the

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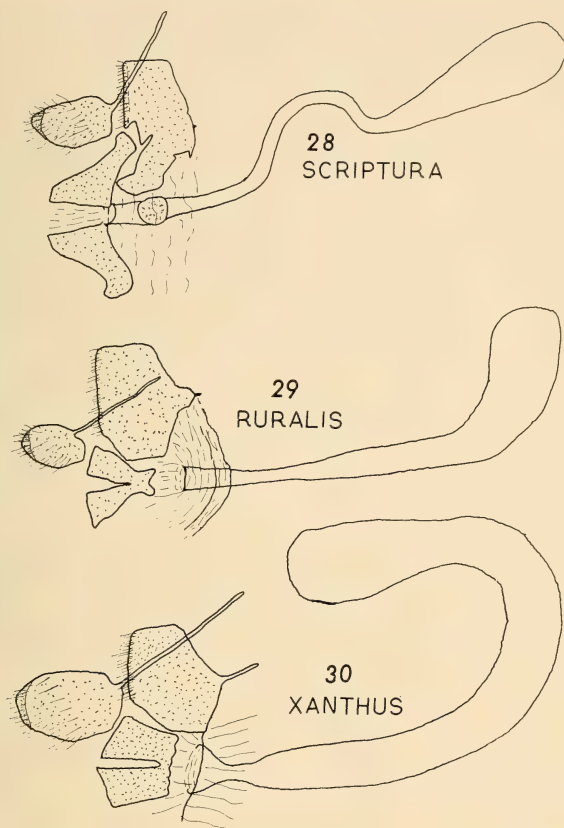
Co., Colorado; 12-13, ♂♂, 14-15, ♀♀, 16, ♂, and 17, ♀, nr. Cloudcroft, Otero Co., New Mexico; 18, ♂, Grandview Lookout, Coconino Co., Arizona; 19, ♂, and 20-21, ♀♀, 5 mi. NW Flagstaff, Coconino Co., Arizona; 22, ♂, Lake Mary Road SE Flagstaff, Arizona; 23, ♂, Ditch Camp, 8000', Apache Co., Arizona; 24, ♀, 16 mi. E. McNary, Apache Co., Arizona.



Figs. 25–27. Male genitalia of *Pyrgus* spp. Lateral view (valvae and aedeagus removed), uncus and tegumen, posterior view and cross section of juxta (C is hole for aedeagus), medial view of right valva, and aedeagus. A and B are valval margins (A — harpe, B — cuiller) (cf. Table 1). Parts differ slightly in scale. 25, Bear Creek, Chaffee Co., Colorado; 26, Clear Creek, 10500', Clear Creek Co., Colorado; 27, nr. Game Ridge, Custer Co., Colorado.

type may have been an interspecific hybrid) near Cloudcroft, New Mexico, and are always associated with *P. anserina* in southern Colorado.

Adult behavior. At high density, males search for females by flying just above the ground near the larval host, and few males occur in gully bottoms. At the usual low density, males mainly wait for females by perching in narrow dry gully bottoms. Courtship, in which male and female flutter about each other, occurs all day. Unreceptive females may fly upward about a meter repeatedly until the male departs. Adults occasionally feed on *Taraxacum officinale* and other flowers, and on manure and mud.



Figs. 28–30. Female genitalia of *Pyrgus* spp. Ventral view, drawn opened on slides; left pre-papillar sclerite (tergum 8?) and left papilla analis omitted. Three drawings differ slightly in scale. 28, Marshall, Boulder Co., Colorado; 29, Copper, Siskiyou Co., California; 30, Howardsville, San Juan Co., Colorado.

Distribution. *P. xanthus* occurs in mountains from southern Colorado to southern New Mexico, northwest along the Mogollon Rim to near Flagstaff, Arizona. It probably occurs in southern Utah but has not yet been found northwest of the Colorado River (* = probable, specimens not examined).

COLORADO. 64 specimens examined. *Douglas Co.*: Russel Ridge, 1-v-73, J. Scott; *Park Co.*: Beaver Creek near Fairplay, 10000', 20-vi-53, Hans Epstein*; near Fairplay, 10500', 30-v, F. M. Brown; Sacramento Creek near Alma, 10500', 31-v-53, F. M. Brown*; Antero Junction, vi-73, R. E. Stanford, M. Fisher; *El Paso Co.*: Beaver Creek, Rampart Range, 9000', 22-v-66, 4-vii-65, Samuel Johnson*; *Chaffee Co.*: near Trout Creek Pass, 19-vi-73, J. Scott; 5 miles W. of Buena Vista, 9000', 16-v-65, 8-vi-65, Samuel Johnson*; Poncha Pass, 9010', 27-v-72, J. Scott; *Custer Co.*:

east of Game Ridge, 9400', 5-vi-71, Juanita Scott, 26-v-72, 18-vi-73, J. Scott; near Rosita, 8800', 26-v-72, J. Scott; *Huerfano Co.*: Devil's Hole, 9100', 15-16-vi-73, J. Scott; *Saguache Co.*: west of junction highway 114 and Luders Creek Road, 9200', 28-v-72, Glenn R. Scott; Luders Creek Camp, 10000', 11-vi-68, 8-vi-69, 30-v-71, Maurice Howard, 6-vi-71, Glenn and Juanita Scott, 23-vi-71, J. Scott; Saguache Park, 10500', 28-v-72, J. Scott; *Costilla Co.*: Culebra Mtn., v-44, Bernard Rotger*; *Conejos Co.*: Torsido Creek west of Capulin, 9700', 2-v-51, B. Rotger*; *Mineral Co.*: Wolf Creek Pass, vi, H. A. Freeman*; *Gunnison Co.*: Gothic, 9500', 20-vi-72, J. Scott; Tincup, 10200', 3-vii-65, M. Howard; Curecanti Creek, 8500', 21-vi-62, S. L. Ellis*; *Montrose Co.*: top of Black Mesa, 9700', -73, S. L. Ellis*; Cottonwood Creek, Uncompahgre Plateau, 8200', 4-vi-61, S. L. Ellis*; *Dolores Co.*: Dolores River near Lizard Head, 8500-9500', 29-v-39, F. M. Brown, J. W. Tilden*; *Archuleta Co.*: 7.7 mi. NE Pagosa Springs, 8-vi-69, S. L. Ellis; Hwy. 29 between Chromo and Chama, 2 mi. NW continental divide, 9-vi-69, S. L. Ellis; *San Juan Co.*: Howardsville, 3-vii-65, J. Scott.

NEW MEXICO. 127 specimens examined. *Colfax Co.*: Raton Mesa, 8800', 3-v-72, J. Scott; *San Miguel Co.*: near Rociada, 8000', 3-v-70, R. E. Stanford*; *Bernalillo Co.*: Sandia Mts., R. Holland*; *Valencia Co.*: Mt. Taylor, K. Roever*; *Otero Co.*: near Cloudcroft, Sacramento Mts., 8700', 21-iv-72, J. Scott; Pine Forest Camp, 8500', 6-v-61, 18-v-63, Kilian Roever; *Catron Co.*: Mogollon Range, 8-v-40, William Burdick.

ARIZONA. 20 specimens examined. *Apache Co.*: Highway 73, 16 mi. E. McNary, 30-v-70, K. Roever; Ditch Camp, North Fork White River, 8000', 30-v-71, K. Roever; *Coconino Co.*: Lake Mary Road, 7 mi. SE Flagstaff, 19-v-68, K. Roever; A-1 Burn, Highway 180, 5 mi. NW Flagstaff, 31-v-64, 31-v-65, 1-vi-63, K. Roever; Grandview Lookout, South Rim Grand Canyon, 20-iv-69, K. Roever; San Francisco Peaks, K. Roever*; Walnut Canyon, 23-iv-67, R. Funk*.

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COMMUNAL ROOSTING IN RELATION TO WARNING COLOUR
IN TWO HELICONIINE BUTTERFLIES (NYMPHALIDAE)¹JOHN R. G. TURNER²

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Communal roosting, reported for few butterfly species, appears to be of three types: (1) night-roosting, associated with repeated homing to the same roost, reported in acraeines, heliconiines, ithomiines and one nymphaline, and apparently occurring only in tropical species (Dewitz, 1877; Jones, 1930; Poulton, 1931; Carpenter, 1931; Moss, 1933; Beebe, 1950; Crane, 1957; Turner, 1971b; Benson & Emmel, 1973); (2) night-time aggregations of temperate grassland butterflies such as blues and satyrids (in Scotland I have noted several dozen *Coenonympha pamphilus* (L.) resting on the head of a flowering herb in late afternoon) which may result only from high population density; and (3) long-term aggregations during diapause, well known for the monarch (*Danaus plexippus* (L.)), and also observed in the tropical nymphaline *Smyrna karwinskii* (Geyer) (Muysshondt & Muysshondt, 1974), and the temperate arctiid moth *Euplagia quadripunctaria* Poda (Johnson et al., 1963). The function of these communes, whether night-roosts or diapause aggregations, is little understood, and it is not even clear how many species in what taxonomic groups have these habits, a situation complicated by the fact (K. S. Brown, pers. comm.) that some heliconiines which roost singly in some times and places, roost communally in others. I shall here discuss night-roosting only.

Two authors have proposed models of the ecology and evolution of tropical butterflies which link together, as part of the same complex of adaptations, communal night-roosting, restricted home range (with homing to roost), great adult longevity and high unpalatability (Benson, 1971; Turner, 1967, 1971a). Others have pointed out that the slow, steady, life-long rates of reproduction associated with these characters are adaptations to the slow but comparatively reliable production of resources needed by both adults and larvae which is characteristic of tropical forests (Benson & Emmel, 1973; Ehrlich & Gilbert, 1973).

Briefly, it is likely to be advantageous to organisms which have some

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protection such as an unpleasant flavour against predators to mass themselves gregariously in one place. In this way a predator which encounters one of them and experiments with tasting it will immediately encounter all the others and leave them alone, whereas if the prey were dispersed a number of them might fall victim to several different predators. This is particularly true if their predators are confined to home ranges, so that gregarious prey encounter fewer individual predators than dispersed prey do. Larvae can be gregarious from the mere laying of a clutch of eggs by the mother, but for butterflies to roost gregariously they must have some means of getting together every night; and it seems that the only way they can do this is by remembering the position of a roosting site. Hence, communal night-roosts will only be found in those species with a limited, learned home range in which they stay during the day, and individuals will tend to home to the same roost night after night. Butterflies that live only a few days are unlikely to learn home ranges or roosting positions, and the only way that night-roosts could develop in short lived or vagile species would be by the marking of the roost with a pheromone. Communication of this kind between unrelated individuals is probably very difficult to evolve. An experiment by Jones (1930) showed that *Heliconius charitonia* (L.) remember the position of their roosts, and do not use a pheromone. Communal roosters should therefore be sedentary and long lived, and great adult longevity coupled with restricted movement will produce the 'viscous' population structure likely to lead to the evolution of unpalatability through kin selection, thus bringing the adaptations full circle into an interlocking set. The evolution of this set of adaptations may be triggered by selection for slow sustained reproduction in the face of limited resources, and hence for great adult longevity, itself much enhanced if the adults are immune from attack by predators.

Thus it is predicted that communal night-roosts will be found in tropical butterflies which are unpalatable, long lived, have restricted home ranges and reproduce slowly. As knowledge of the roosting site is essential, it is further predicted that all communal roosters will repeatedly home to the same roost.

Communal roosting has long been known in heliconiine butterflies, which have the above characters to varying degrees, and it is the purpose of this note to record my observations of communal roosting in two of the less studied species. I have already mentioned these observations as "unpublished" in various papers, but feel that it may be helpful to set them down.

OBSERVATIONS

Heliconius ethilla (Godart) flies in the rainforests clothing the lower slopes of the Northern Range in Trinidad, where it has recently been the subject of a most elegant study on its longevity and home range behaviour by Ehrlich & Gilbert (1973). The only communal roost of this species which I have seen was in the lower canopy of the rainforest which formed a closed roof over parts of Andrew's Trace, where Ehrlich and Gilbert carried out their experiments. At 1745 ST on 12 August 1964, I observed a number of this species fluttering around a group of leafless twigs in the canopy in the way that is characteristic of *Heliconius* when they are preparing to roost for the night. Occasionally some of them would flutter lower onto the vegetation at the edge of the path. By 1815 ST all had settled on the twigs and the dusk in the forest had become quite deep. I returned at midnight that night and was able with glasses to count seven roosting butterflies. I became somewhat concerned about their identity, because around 1800 ST I had been able to net one of the butterflies flying beneath the roost at the edge of the path, and this turned out to be *Tithorea harmonia* (Cramer), the muellerian comimic of *H. ethilla*.

Doubts about the identity of the butterflies in the roost were dispelled on 15 August when at 2300 ST in heavy rain I was able to observe the roost with a small but powerful telescope; it contained seven undoubted *Heliconius ethilla* and no *Tithorea*. The *Tithorea*, which had been captured during the previous observations, had been kept in one of the New York Zoological Society's insectaries at Simla in the interim and had been marked and released, along with another individual from just north of Port of Spain, immediately below the site of the *H. ethilla* roost at around mid-day on 15 August. Neither of these butterflies was in the roost when it was observed at 2300 ST, and I concluded that this particular roost consisted entirely of the *Heliconius*. It would be interesting to know if the comimics ever do roost together. (*T. harmonia* has been observed in roosts of *Heliconius erato* in Brasil as reported by Vasconcelos Neto & Brown, pers. comm.). I last observed the roost on 27 August, when it was still occupied.

Dryadula phaetusa is one of the heliconiines which have departed rather little from the nymphalid appearance which one assumes is the ancestral form of the whole group. Yet it too appears to have developed the habit of communal roosting which is little known in the rest of the nymphalids. I did not succeed in making any observations of this species roosting in the wild, but while preparing to carry out some observations on its courtship for Miss Jocelyn Crane at the New York

Zoological Society's Research Station, I kept half a dozen males in one of the extremely large cages ($20' \times 30' \times 20'$) which were used for observations of this kind. One evening at dusk Miss Crane noted that the butterflies appeared to be roosting communally in the cage. I was able to observe and photograph this on subsequent evenings. The floor of the cage was grassy, and the males were indulging in typical heliconiine roosting behaviour, fluttering around blades of grass and eventually settling, most of them lined up with their heads pointing in the same direction on the underside of the same large grass blade. It seems likely that this is their normal method of roosting, as *D. phaetusa* is a butterfly of comparatively open country, unlike many of the heliconiines which prefer densely wooded growth and roost either on dried twigs as described above or on the remains of dried creepers hanging from trees. My observation of communally roosting *Heliconius* in cages where they do not have the twigs or the vines, is that they roost more or less aggregated on the fabric or wire either of the roof or the sides of the cage at some distance from the ground, and never attempt to roost on the ground vegetation as the *D. phaetusa* were doing. The *D. phaetusa* on the other hand were never observed roosting on the roof or the sides of the cage, which leads me to believe that roosting on grass blades or other green vegetation is normal for them in the wild. (I understand from correspondence that this has been confirmed in the wild by Benson.)

DISCUSSION

Heliconius ethilla fits well into the above theories about the functional value of communal roosting. It is not known whether it homes to the roost, but it does have a strictly patrolled home range and is one of the most unpalatable members of the genus (Ehrlich & Gilbert, 1973; Brower, Brower & Collins, 1963). Its confirmed longevity and slow rate of reproduction were used by Ehrlich & Gilbert as the basis for their model of adaptation in tropical forest butterflies. Both *Heliconius erato* (L.) (unpalatable, home range, long lived) and *H. charitonia* (palatability and home range unknown, probably long lived) show a strong tendency to home to the same roost (Jones, 1930; Beebe, 1950; Turner, 1971b). *Heliconius melpomene* (L.) and *H. sara* (Fabricius) both roost communally and are both unpalatable.

Very little is known about *Dryadula phaetusa*; its palatability, longevity, home range and roost-homing have not been investigated. Among the known palatable heliconiines, *Agraulis vanillae* (L.) and *Dryas iulia* (Fabricius), there is little or no tendency to roost communally (Crane,

1957). There is one casual observation which suggests that *D. phaetusa* is long lived. *Heliconius* species require, for reasons that are controversial, a source of amino acids, which they obtain from pollen; this need seems to arise from the long adult life-span (Gilbert, 1972). On Barro Colorado Island (Canal Zone) in 1975, I observed a male *D. phaetusa* palping a bird-dropping with his proboscis; Brown (1973) has photographed the same behaviour in *Heliconius aliphera* (Godart) in Brasil (I have noted this also in Panamá), and it presumably shows that the butterfly requires amino acids or other nitrogen compounds.

D. phaetusa, more than any other heliconiine, has the rounded wings and rather dull colour (particularly in the female) typical of nymphalines; it has all the appearance of a "primitive" species. However, in its roosting behaviour it is clearly not "primitive", and this term should only be used of particular characters, never as a blanket term for a whole species. It does have two striking similarities to *Marpesia berania* (Hewitson), the only nymphaline known to roost communally, which in accord with the model, is very long lived and homes faithfully to its roost (Benson & Emmel, 1972). Both species are orange-brown, rather than obviously warningly coloured, and both are sexually dimorphic, with duller-coloured females. This strongly suggests that communal roosting and at least some of the habits that go with it are not necessarily accompanied by unpalatability.

CONCLUSIONS AND SUMMARY

Communal roosting for the night seems to occur only in tropical butterflies which are of low vagility and which are long lived; in all cases investigated it has been found that the individual butterflies tend to home repeatedly to the same roost. This is expected in theory and what is known of the biology of *Heliconius ethilla* and *Dryadula phaetusa*, whose communal roosting as reported here, tallies with this generalisation. The suggestion that communal roosting is associated with unpalatability may or may not be true in general: the heliconiine *D. phaetusa* and the nymphaline *Marpesia berania*, both communal roosters, are not obviously warningly coloured and may be palatable.

The communal roosting of both temperate and tropical butterflies and moths during diapause is obviously a rather different phenomenon.

ACKNOWLEDGMENTS

This work was carried out while the author was working for the New York Zoological Society's Department of Tropical Research in Trinidad, and was supported by grants from the Nature Conservancy

(UK), the University of Oxford, the University of Liverpool and the National Science Foundation (Grants No. B039300 and GB2331).

I am grateful to Dr. K. S. Brown Jr. for his helpful comments on the draft of this paper, and to Jocelyn Crane-Griffin, then Director of the New York Zoological Society's research station in Trinidad, for her hospitality and encouragement.

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A NEW SPECIES OF *EUPHYES* SCUDDER FROM TEXAS (HESPERIIDAE)

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Euphyes macguirei Freeman, new species

Male. Upper side: Primaries dark brown. Well developed, black stigma extending from vein 1 to the cell. Four discal spots of about equal size which extend from space 1b to space 3 in a straight line, just outside of the stigma. There may be present a minute phantom spot in space 5. There is only one apical spot present and that one is in space 6. Fringes light fulvous, unchecked.

Secondaries dark brown with a distinct fulvous streak in the cell. Fringes light fulvous, unchecked.

Under side: Primaries, apex and costal area yellowish-brown, the cell and base of wings black with the remainder light brownish-black. Discal spots in spaces 2 and 3 bright fulvous. A broad yellowish-white spot in space 1.

Secondaries, chocolate brown with veins yellow. A distinct fulvous streak extending throughout the cell to near the marginal border.

Thorax above dark brown, beneath lighter in coloration. Abdomen above dark brown, beneath sordid white. Head heavily overscaled above with greenish-yellow hair-like scales. Palpi bright yellow with a few scattered black scales present. Legs yellowish-brown. Antennae, shaft black ringed obscurely with yellow, and the club black above, beneath the shaft is more yellowish and the club is yellow at the base and the apiculus, the remainder black.

Wing measurements: Holotype ♂, primaries: base to apex, 13.5 mm; apex to outer angle, 9 mm; outer angle to base, 11 mm. Secondaries: base to end of vein 3, 11 mm; center of costa to anal angle, 10 mm. Total expanse of mounted specimen, 29 mm.

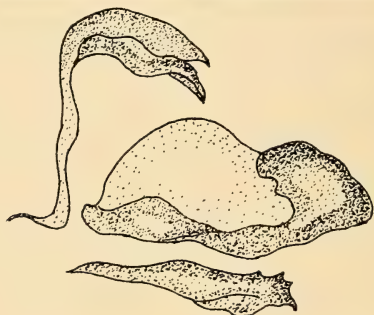
Female. Upper side: Primaries dark brown. A small circular fulvous spot in space 1 situated inward from the spot in space 2. In space 2 there is a bright fulvous, oval spot. In space 3 there is a narrow, somewhat elongated, bright fulvous spot centered over the outer half of the spot in space 2. In space 6 there is a linear apical spot of the same bright fulvous coloration as the discal spots. Fringes light fulvous, unchecked.

Under side: Primaries, costa, apex and extending two thirds down the outer margin yellowish-brown, with the veins yellowish. Base and remainder of wings brownish-black. A narrow, linear, yellowish spot in space 1a. In space 1b there is a minute, yellowish dot situated directly below the spot in space 2. Discal spots in spaces 2 and 3 bright fulvous. Fringes dark brown except at the outer angle where they become fulvous.

Secondaries, light, yellowish-brown, with veins yellow. An indistinct, fulvous, streak in the cell area extending from base to outer margin. Anal angle is brownish-black.

Thorax above dark brown, beneath yellowish-brown in coloration. Abdomen dark brown above, beneath yellowish-white, with an indistinct brown line down the center. Head brown, heavily overscaled with fulvous hair-like scales. Palpi bright yellowish-white, with a few scattered black scales present. Legs yellowish-brown. Antennae same as males.

Wing measurements: Allotype ♀, Primaries: base to apex, 16.5 mm; apex to



5.

Figs. 1 & 3, *Euphyes macguirei* Freeman, holotype ♂, Benbrook Res., Tarrant Co., Texas, 6 Oct. 1973, W. W. McGuire. 2 & 4, *Euphyes macguirei* Freeman, allotype ♀, Benbrook Res., Tarrant Co., Texas, 6 Sept. 1973, W. W. McGuire. 5, Male genitalia, *Euphyes macguirei* Freeman, paratype, Benbrook Res., Tarrant Co., Texas, 19 Sept. 1973, W. W. McGuire.

outer angle, 10.5 mm; outer angle to base, 13.5 mm. Secondaries: base to end of vein 3, 13 mm; center of costa to anal angle, 12 mm. Total expanse of mounted specimen, 33.5 mm.

Type material. Holotype ♂, Benbrook Res., Tarrant Co., Texas, 6 Oct. 1973, W. W. McGuire collector, will be placed in the American Museum of Natural History, New York. Allotype ♀, same location and collector, 6 Sept. 1973, in the collection of H. A. Freeman. There are three male paratypes from the same location

and collector, one ♂, 6 Oct. 1973, and one ♂, 13 Sept. 1973, are in the collection of W. W. McGuire, and one ♂, 19 Sept. 1973 in the H. A. Freeman collection. All specimens are "ex larvae," reared on *Carex* sp. by W. W. McGuire.

This new species seems to be intermediate between *Euphyes dion* (Edwards) and *E. bimacula* (Grote & Robinson). It differs from *E. dion* in the following ways: (1) smaller size; (2) more elongated fulvous streak throughout the cell in the ♂♂ on the secondaries; (3) the absence of fulvous markings between the stigma and the base of the wings; (4) the yellowish veins on the lower surface of the secondaries, which are absent or else poorly defined in *dion*; and (5) in the genitalia. It differs from *E. bimacula* in the following ways: (1) smaller size; (2) the presence of a fulvous streak throughout the cell on the secondaries; (3) the darker fringes of the wings; (4) *bimacula* may or may not have fulvous markings between the stigma and the base of the wings on the upper side of the primaries which are completely absent in *macguirei*; (5) on the lower surface of the secondaries in *bimacula* the veins are usually concolorous with the rest of the wing, while in *macguirei* they are yellowish being lighter than the ground color; (6) in *macguirei* all discal spots are much brighter fulvous than in *bimacula*; and (7) the genitalia are different.

I take great pleasure in naming this new species for my good friend, Dr. W. W. McGuire of Galveston, Texas, who collected the type series and is doing such outstanding work on the American Hesperioidea.

ACKNOWLEDGMENT

I would like to express my deepest thanks to the National Geographic Society which made this study possible.

SYSTEMATIC NOTES ON *DRYAS IULIA* (HELICONIIDAE)

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Dryas iulia Fabricius 1775 is a distinctive, common, and widespread neotropical heliconiid. Its many subspecies have been reviewed partially or completely by Riley (1926), Comstock (1944), Emsley (1963), and Brown & Heineman (1972). Despite this attention, several matters of taxonomic and systematic importance remain unresolved. Five of these are discussed here: (1) a new subspecies for the Florida populations; (2) resurrection of the name *alcionea* Cramer for the South American subspecies; (3) revised authorships of the Cuban and the Central American subspecies; (4) fixation of a type locality for the name *cillene* Cramer and the consequent disposition of that name; and (5) notes on systematic affinities among the various subspecies.

***Dryas iulia largo* Clench, new subspecies**

Superficially closely resembling *carteri* Riley 1926 (Bahamas) and *nudeola* Bates 1934 (Cuba), but differing in these respects: from both in the absence of androconia on veins M_2 and M_3 of the fore wing above in males, and in the slightly heavier, basally directed fuscous "teeth" on the termen in interspaces M_2 - M_3 - Cu_1 . Additionally it differs from *carteri* in both sexes by the absence of a purplish cast to the underside (common, but not universal, in *carteri*), and from *nudeola* by the shape of the cell-end bar in the male on the fore wing above: its sides are parallel or anteriorly convergent in *largo* (as in *carteri*), posteriorly convergent in *nudeola*.

Holotype. Male, Key Largo, Monroe Co., Florida, "2/10/30" [10 Feb. or 2 Oct.], leg. J. R. Haskin, figured in color in Holland (1931: pl. 71 fig. 1) as "*Colaenis cillene*."

Paratypes. 1 ♂ 1 ♀, same data as holotype, the female figured in Holland (1931: pl. 71 fig. 2); 6 ♂ 9 ♀, same locality, 1-7.viii, *ex coll.* W. R. Sweadner (and possibly collected by him), C. M. Acc. 12938; 1 ♀, same locality, 3.i.1945, leg. A. Avinoff, C. M. Acc. 13495; 3 ♂ 3 ♀, same locality, 21-23.iv.1964, leg. A. I. Good, *ex coll.* A. I. Good, C. M. Acc. 24049; 1 ♂ same locality, 15.ii.1958, leg. Lee A. Pollard, *ex coll.* L. & S. Miller, C. M. Acc. 21269 and 21733; 1 ♀, NE corner of Monroe Co., Florida, 22-31.vii, *ex coll.* W. R. Sweadner (possibly collected by him), C. M. Acc. 12938. In all, 11 ♂ 15 ♀ paratypes.

Holotype and all paratypes, C. M. Ent. type series no. 678.

Most authors (e.g., Klots, 1951) have held this to be the same as the Cuban subspecies, which usually has been called (incorrectly: see be-

low) *cillene* Cramer. Bates (1934, 1935) thought that Florida specimens more resembled those of Cuba (in which he was correct), but concluded that at least provisionally Cuban, Bahamian, and Floridian specimens should all be united under one name, *nudeola*. Brown & Heineman (1972) similarly lump all three. Emsley (1963), however, pointed out the distinctive androconial difference separating the Florida subspecies from those of Cuba and the Bahamas, and he recognised all three subspecies; but he incorrectly called the Florida form *cillene*.

Dryas iulia alcionea Cramer 1779 (New Status)

Cramer (1779: 38, under *cillene*) gives Suriname as the type locality for both *cillene* and *alcionea*. His figures of *cillene* show that this locality is incorrect for that name (see below); but the figures of *alcionea* (*op. cit.*: pl. 215 figs. A, F, G) agree well with Guiana specimens before me, and Suriname can be taken as the probable source of *alcionea*.

Two names have been applied to the South American subspecies in the past: nominate *iulia* Fabricius 1775 and *cillene* Cramer 1779. Brown & Heineman (1972) show that nominate *iulia* actually came from St. Croix, Virgin Ids., with *juncta* Comstock 1944 (TL: Puerto Rico) accordingly a synonym. The name *cillene* is shown below to have been based on Jamaican material. This leaves *alcionea* as the oldest available name for the South American subspecies. The name *titio* Stichel 1907 (TL: Bolivia) falls to *alcionea* as a synonym: I have examined a series of specimens from Bolivia and can see no way to separate them from Guiana material. The subspecies *alcionea* is widely distributed in South America, including Trinidad and Tobago, but is replaced along the Pacific coast southward to Ecuador by the otherwise Central American subspecies *moderata*.

Authorships of the Names *nudeola* and *moderata*

Brown & Heineman (1972) correctly note that the name *nudeola*, as originally proposed by Stichel (1907), is inadmissible under the International Code of Zoological Nomenclature. Stichel gave it explicitly as an infrasubspecific form, a quadrinomial. Bates (1934, 1935) raised *nudeola* to subspecific status, by which action he becomes the author of the name, as Brown & Heineman point out. They, however, mistakenly thought that Bates first took this step in 1935, whereas the original action was a year earlier (Bates 1934). The correct name for this subspecies, which inhabits Cuba, Isla de Pinos, and perhaps also the Cayman Islands, is therefore *Dryas iulia nudeola* Bates 1934.

By the same token, authorship of the name for the subspecies *moderata* (which inhabits Central America from Texas to Panama and on into South America along the Pacific coast to Ecuador) must also be changed. Stichel (1907) gave the name quadrinomially to a nearly immaculate male from Honduras. Riley (1926) appears to have been the first to use the name in a subspecific way, so *moderata* must correctly be attributed to him: *Dryas iulia moderata* Riley 1926.

The subspecies *moderata* is quite variable, males ranging from a nearly immaculate form to one that is rather well marked with fuscous. Emsley (1963) restricted the name *moderata* to the nearly immaculate form and applied the name of the South American subspecies (which he incorrectly called *i. iulia*) to the darker form. By his strange interpretation, then, two different subspecies occur sympatrically in Central America. This, of course, is wrong. First, the two forms are connected by intermediates in quantity and in all degrees; second, the darker form at its darkest is still considerably more lightly marked than is *alcionea*; and third, sympatric subspecies are ordinarily impossible and should never be considered without a full explanation of what would have to be most extraordinary circumstances. This Emsley does not give, nor do I know of any reason for such a view.

The Name *cillene* Cramer 1779

This name has long been a subject of controversy. Cramer (1779: 38, pl. 215 figs. D, E) figured *cillene* and cited its locality as Suriname. The figure shows a bright, nearly immaculate male with a cell-end spot, no spot on M_3 , a dusting of black scales along the costa and radial vein just beyond the cell, a well crenulated hind wing termen with a sprinkling of fuscous scales in a similarly crenulate, thin terminal band. Despite Bates's (1934) statement that Cramer's figure of *cillene* "can be matched with specimens from northern South America much more easily than with Cuban ones" (so completely incorrect that I can only assume that he had before him from "northern South America" either mislabelled specimens or material from the western South American portion of the range of *moderata*), it is immediately evident that Cramer's figure represents a specimen from some area other than South America.

Opinions on the application of the name *cillene* have been remarkably diverse. Bates (1934, 1935) considered it South American (Suriname); Riley (1926), Comstock (1944), and many others have considered it Cuban. Emsley (1963) used it, strangely, for the Florida subspecies (as distinct from that of Cuba). Brown & Heineman (1972) were uncertain of its application.

It is most unlikely that Cramer had any Cuban material at all (Bates, 1934), and even more unlikely that he had any material from southern Florida. Suriname, the given type locality, is equally unlikely because of the appearance of the figured specimen. Whence, if not from one of these places, might Cramer's *cillene* have come?

Cramer did have access to Jamaican material (Brown & Heineman, 1972), so I have considered this possibility. I carefully compared his figures with a large Jamaican series (42♂ 24♀) and this comparison has convinced me that his specimen was in all probability of Jamaican origin. These points are significant:

Most similarly pale populations (notably those of Florida, Cuba, the Bahamas and usually Middle America) have the hind wing border of the male consisting of a thin terminal black line (usually divided lengthwise by an exceedingly thin pale line) and a basad row of crenulations, two per interspace. In Jamaica this is rarely true. Usually the hind wing border is so thin and linear as to appear almost absent, in which it resembles some Middle American pale phase specimens; but sometimes it is heavier, and the thickening appears to be simply a sprinkling of black scales along the border, following the border but not arranged in any linear pattern. I have seen this particular border only in specimens from Jamaica. It is exactly what Cramer depicts in his figure of *cillene*.

The hind wing of the Jamaican subspecies is noticeably more deeply crenulate than in any other subspecies of *iulia*, a major character separating it from the pale phase *moderata* (Riley, 1926), which it otherwise often much resembles. These deep crenulations are accurately shown in Cramer's figure of *cillene*.

The cell-end spot on the fore wing above is mostly absent or exceedingly thin and linear in Jamaican males, but it does appear, about as strong as Cramer shows, in some Jamaican specimens (2♂, Low River and Christiana).

Cramer's figure of the underside shows on the hind wing a dark (orange-ocher) waved pm or st line, and a basal dark area consisting only of an anterior large spot (Rs-M₂) and a posterior small one (Cu₁-Cu₂). In Cuban specimens the space between the waved line and the termen is usually filled with darker color (grayish pink-ocher) and the basal area of the wings is solidly dark. In many Jamaican specimens, however, the colors and pattern agree closely with Cramer's figure and even in those with a darkened basal area the places corresponding to the spots in Cramer's figure are darker still and stand out as spots or patches.

In short, the characteristics shown by Cramer's figures of *cillene* are all Jamaican, some of them uniquely so. Specimens from no other area agree even remotely as well. I conclude that Jamaica must have been the source of *cillene* and accordingly designate that island as type locality.

The name *delila* Fabricius 1775 (described as from "America") was also in all probability based on a Jamaican specimen (Brown & Heineman, 1972). It has four years' priority over *cillene*, which must therefore be placed as a synonym: *Dryas iulia delila* Fabricius 1775 (= *cillene* Cramer 1779, new synonymy).

Systematic Affinities Among the Subspecies

It seems not to have been noticed before that the many subspecies of *Dryas iulia* can be divided into two groups according to the color of the costal area of the hind wing upperside of the female. These may be called (i) *the Antillean group*, in which this costal area is nearly as dark as the rest of the wing and contrasts conspicuously with the white costal area of the male; and (ii) *the Continental group*, in which this costal area is white like that of the male.

The following check list of *iulia* subspecies shows how they are apportioned between the two groups. I have seen no females of nominate *iulia*, *warneri*, *dominicana*, *martinica*, *lucia* or *framptoni*. Dr. Frederick H. Rindge kindly examined material in the American Museum of Natural History for me and he reports (*in litt.*) that females of nominate *iulia* have dark costal borders (Antillean group), and that females of *dominicana* have costal borders "light or with some dark," which could indicate that the transition from the light bordered Continental group to the dark bordered Antillean group occurs on Dominica. The remaining unexamined subspecies I have placed solely on the basis of geography. It should be noted that Brown & Heineman (1972) have synonymized *warneri* to nominate *iulia*, but evidently only on theoretical grounds. Pending actual study of specimens I recognise it, as did Comstock (1944).

Dryas iulia Fabricius 1775

(i) Antillean group

- a. **largo** Clench, n. ssp. Southern Florida.
- b. **nudeola** Bates 1934. Cuba; Isla de Pinos; Cayman Ids. (?).
- c. **carteri** Riley 1926. Bahamas.
- d. **hispaniola** Hall 1925. Hispaniola.
- e. **iulia** Fabricius 1775. Puerto Rico; Virgin Ids. (TL: St. Croix).
= *juncta* Comstock 1944 (TL: Adjuntas, Puerto Rico).
- f. **warneri** Hall 1936. St. Kitts.

(ii) Continental group

- g. **dominicana** Hall 1917. Dominica; Guadeloupe.
- h. **martinica** Pinchon & Enrico 1969. Martinique.
- i. **lucia** Riley 1926. St. Lucia.
- j. **framptoni** Riley 1926. St. Vincent; Barbados; Grenadines; Grenada.
- k. **alcionea** Cramer 1779. Most of South America.
= *titio* Stichel 1907 (TL: Bolivia)
- l. **moderata** Riley 1926. Middle America from Texas to Panama, and southward along the Pacific coast of South America to Ecuador.
- m. **delila** Fabricius 1775. Jamaica.
= *cillene* Cramer 1779 (TL: Jamaica).
= *delia* dos Passos 1964 (misspelling of *delila*).

It is clear that *D. iulia* has reached the West Indies by two different routes. One of these was evidently northward from South America along the Lesser Antilles into most of the Greater Antilles and Florida; the other was from Middle America (perhaps from the bulge of Honduras/Nicaragua) to Jamaica, the only island in the Greater Antilles with a representative of the Continental group.

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BIOLOGICAL NOTES ON *LOXOSTEGE FLORIDALIS*
(PYRALIDAE)¹

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The genus *Loxostege* has a worldwide, largely north temperate distribution and includes several economically important species. The sugar beet webworm, *Loxostege sticticalis* (Linnaeus), is a major Holarctic pest, while the garden webworm, *L. rantis* (Guenée) is an important North American pest. *L. similis* of authors has been incorrectly used in place of the correct name, *L. rantis*: the distinct *L. similis* (Guenée) is South American (Capps, 1967). Seven species of *Loxostege* are recorded from Florida (Kimball, 1965).

Loxostege floridalis Barnes & McDunnough (Fig. 1) was described in 1913 as a subspecies of the more widespread *L. albiceralis* (Grote). E. G. Munroe (pers. comm.) is currently revising the Nearctic Pyralidae and considers *L. floridalis* to be a distinct species. Barnes & McDunnough (1913) collected larvae of *L. floridalis* on "Florida cranberry" from "Everglade, Fla." (probably Everglades City, Collier County, Florida). There are no other published records using the common name of "Florida cranberry" but the description provided by Barnes and McDunnough suggests it to be *Lycium carolinianum* Walter (Solanaceae), the actual host plant of *Loxostege floridalis*. The plant is commonly known as Christmas-berry, because of the red fruits on the bushes during December. It is native only to coastal areas in Florida and west to Texas, with a record for coastal South Carolina. Although the host plant is used in inland Florida as an ornamental, *L. floridalis* has been recorded only from coastal areas in Florida as far north as Titusville on the Atlantic Coast and Cedar Key on the Gulf Coast.

Larvae of *L. floridalis* collected at Cedar Key were reared in a laboratory in Gainesville, Florida; eggs were not studied.

Larval Biology

Loxostege floridalis has been recorded feeding only on *Lycium carolinianum*. The related *Loxostege albiceralis* has been reared in Texas by R. O. Kendall on *Lycium carolinianum* var. *quadrifolium* C. L. Hitchie (Munroe, pers. comm.). *Loxostege sticticalis* is a much more general

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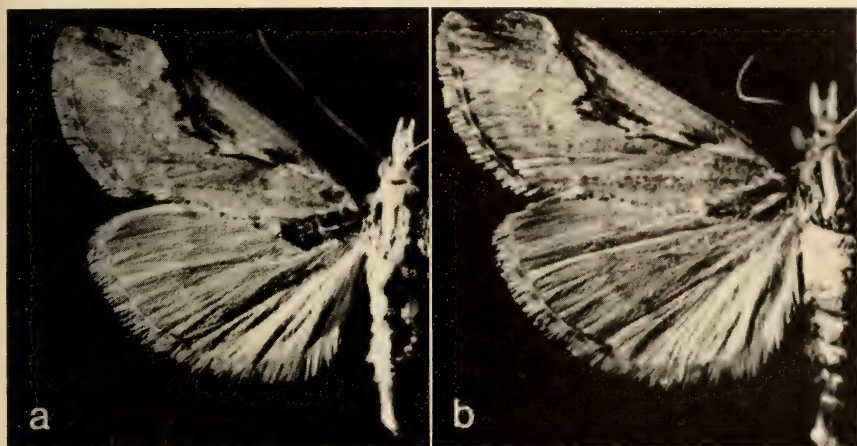


Fig. 1. Adults of *Loxostege floralis*: (a) male, dorsal aspect (wing expanse 26 mm); (b) female, dorsal aspect (wing expanse 29 mm) (both from Cedar Key, Levy Co., Fla.: male emerged 24 Jan 74, female emerged 26 May 74).

feeder and has been recorded from a variety of plants (Pepper & Hastings, 1941), three of which are species of Solanaceae. The genus is large and fewer species appear to be as restricted to one host as is *L. floralis*.

On 13 December 1973, 12 fifth (last) instar larvae of *Loxostege floralis* were found feeding on *Lycium carolinianum* at Cedar Key, Levy County, Florida. The larvae were found clustered as a group among several branches, with some silk webbing evident. The communal feeding of *L. floralis* is similar to that reported for *L. sticticalis* larvae (Pepper & Hastings, 1941). On 19 December 1973 only one fifth-instar larva was found at the same locality but a number of early second-instar larvae (Fig. 2a) were found clustered on one branch. In the laboratory the larvae of 13 December 1973 became prepupal by 26 December, spun cocoons, and pupated by 2 January 1974. Adults emerged as early as 10 days after pupation. The last-instar larva collected on 19 December 1973, which was subjected to a longer period of natural conditions than the larvae reared in the laboratory, was the only larva to enter diapause after cocoon formation. It was allowed to enter sand, where it constructed an ovate cocoon by 2 January 1974. The cocoon was composed of a thick layer of silk and encrusted with sand particles, making it very stiff and resistant to crushing. The cocoon was 21 mm long, about twice the pupal length. The cocoon had a bulbous apical, hollow chamber that barely became covered by sand



Fig 2. Larvae of *Loxostege floridalis*: (a) early 2nd-instars ($2\times$) clustered among leaves of host, *Lycium carolinianum*; (b) 5th-instar ($3\times$), dorsal aspect (all from Cedar Key, Levy Co., Fla., 19 Dec 73).

when in the substrate and it was separated internally from the main pupal chamber by a thin layer of silk. On 12 May 1974 the cocoon was removed from the sand and found to still contain a prepupal larva, which pupated shortly thereafter, and a female emerged on 26 May (Fig. 1b).

Paddock (1912) and Pepper & Hastings (1941) also record substrate cocoon formation for *L. sticticalis* but the cocoon is about twice the length of the *L. floridalis* cocoon; very elongate and without a separate, hollow bulbous apical chamber. In both species the apex of the cocoon is just below the substrate surface, although Pepper & Hastings (1941) observed that larvae of *L. sticticalis* make their cocoons deeper in the substrate during colder weather in Montana. *L. rantalis* has a cocoon similar to that of *L. sticticalis* and has similar behavior (Smith & Franklin, 1954). During the winter *L. floridalis* larvae diapause under natural

conditions much as *L. sticticalis* larvae do in the first generation in May. Pepper & Hastings (1941) found a variable percentage of larvae of *L. sticticalis* from the same egg lots to enter larval diapause in May-June in Montana. The factors that induce larval diapause in some larvae but not in others are not yet known.

Second-instar larvae of *L. floralis* collected on 19 December 1973 at Cedar Key molted on 23, 26, and 31 December (only a few were not synchronized), becoming prepupal by 9 January 1974. Of 40 larvae reared about half had spun cocoons in the rearing bags by 11 January 1974, with pupation occurring from 12-21 January. Adults of pupae formed by 12 January emerged on 24 January and sequentially thereafter with an average pupation period of 12.2 days. Pupation periods in *L. sticticalis* are in the same range of two weeks time in the summer for those larvae not diapausing (Pepper & Hastings, 1941).

Larva

Last-instar larvae of *L. floralis* (Fig. 2b) dark gray, with a line of merging yellow spots on either side of midline adjacent to dorso-lateral elevated pinacula. Elevated pinacula become larger on segments nearer head, forming scoli on the dorsum of meso- and metathorax. Pinacula and scoli black, ringed with yellow on integument. Lateral to pinacula, a longitudinal line of merging orange spots margined with yellow. Lower lateral pinacula have integumental yellow bars at bases. Prolegs and venter, gray; thoracic legs, black. Head capsule, orange with most of vertex black, lower frons black, clypeus white, and labrum black. Last-instar larvae 26-32 mm in length.

A more extensive larval description is not included because S. Allyson (Canada Department of Agriculture) is currently preparing detailed larval descriptions for the Nearctic species of *Loxostege*.

Pupa

Pupa of *L. floralis* (Fig. 3-4) yellow-brown with dark brown markings. Most of markings on dorsum of abdomen. Pupae average 11 mm long, 4 mm wide. Head produced to a point apically. Mesothorax moderately convex dorsally, flattened in the center, and prominently divergent from metathorax in lateral aspect (Fig. 4a). All 10 abdominal segments visible; segments 1-8 have similar dark brown marking on each segment (Fig. 3a). Spiracles of abdominal segments 2-3 surrounded by conspicuously dark, heavily sclerotized enlargements of exoskeleton. Setae, sparse. Proleg scars visible on abdominal segments 5-6 ventrally. Cremaster (Fig. 3b) has six posteriorly directed setae and two dorsal recurved hook-like setae. Cremaster of female as illustrated (Figs. 3-4); male cremaster bulbous (twice ♀ size) to enclose larger genitalia.

The pupa of *L. floralis* is similar morphologically to that of *L. sticticalis* but the lighter coloration and lack of brown markings in *L. sticticalis* will distinguish the two species. Pupae of other *Loxostege* species were not available for comparisons.

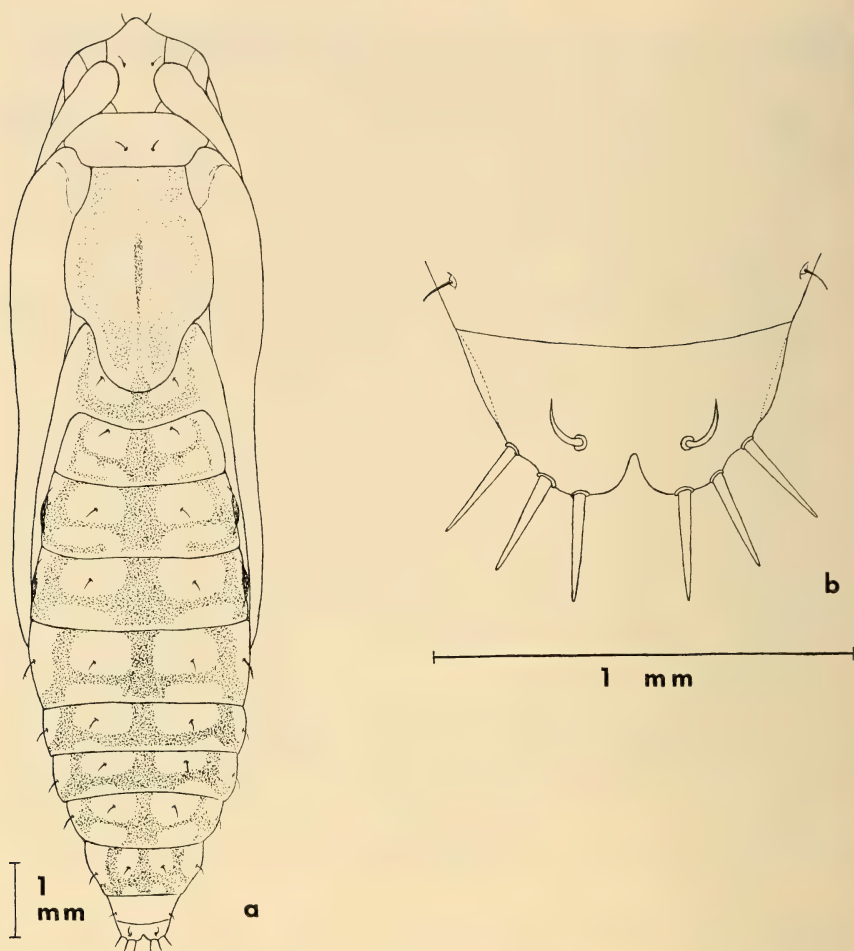


Fig. 3. Pupa, ♀, of *Loxostege floridalis*: (a) dorsal aspect; (b) cremaster, dorsal aspect (Cedar Key, Levy Co., Fla.).

Adult Biology

Nothing has been published on the behavior of adult *Loxostege floridalis* but inferences can be made from studies of the congeneric species. *L. sticticalis* is bivoltine with a larval diapause of up to 10 months, from July until the following May, in Montana (Pepper & Hastings, 1941). Published records of *L. floridalis* indicate a similar pupation-emergence behavior but a multivoltinism commensurate with the more moderate Florida climate (Kimball, 1965). *L. floridalis* evidently has four generations in Florida. December larvae become adults during

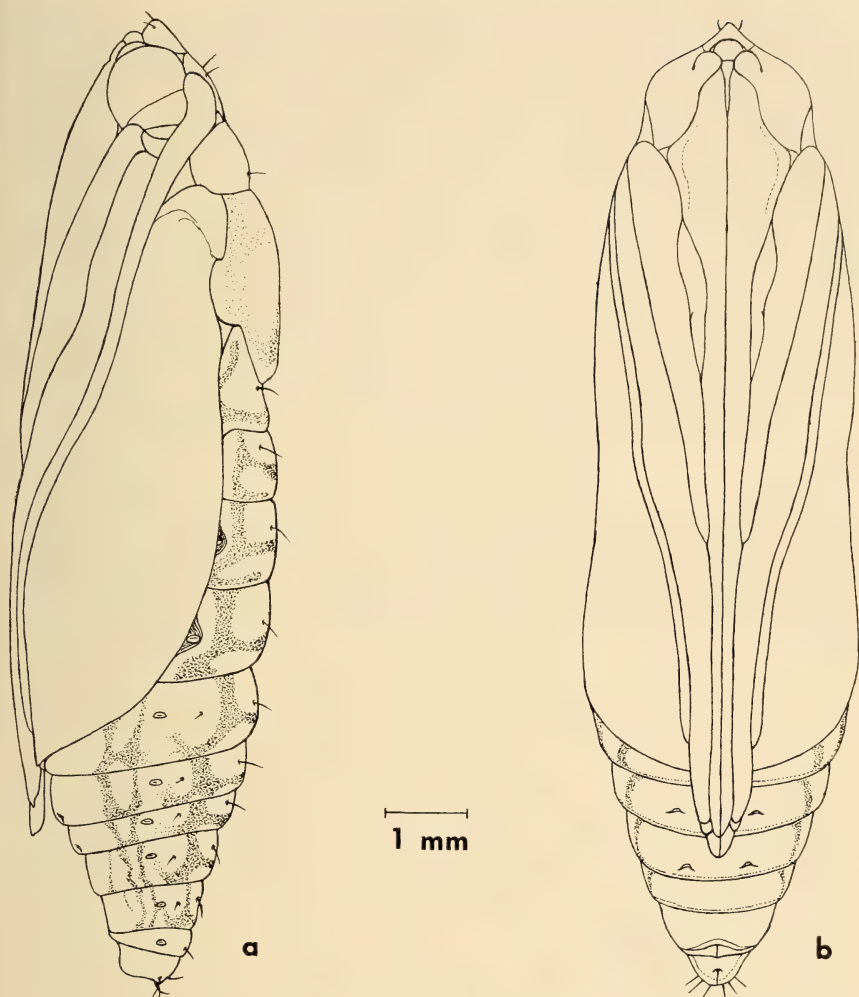


Fig. 4. Pupa, ♀, of *Loxostege floridalis*: (a) lateral aspect; (b) ventral aspect (Cedar Key, Levy Co., Fla.).

January and February except for a percentage of larvae that diapause until May. Although the winter is mild in coastal southern Florida, there is a dry season from mid-winter to June, making diapause useful to insure survival of the population in the event of a particularly dry spring. The second generation of adults emerges in May and the third generation emerges in September. Adults present in November form the fourth generation that produces progeny for the January adults.

From collections data there appears to be a sequential emergence of adults of *L. floridalis* to produce adult activity over a longer time period than delineated above for the four generations. A similar emergence overlap is found with *L. sticticalis* in Montana (Pepper & Hastings, 1941). Available records, however, indicate a lack of adults of *L. floridalis* from June–August. The voltinism of *L. floridalis* has not yet been fully studied, but it is possible that a portion of the June larvae do not emerge as adults until November, much as some larvae of the winter generation partially bypass one generation and wait until May to emerge. The remainder of the June larvae may estivate until September rather than emerge after two weeks as in other generations. Such a strategy would be adaptive to insure survival of a portion of the population during adverse conditions such as excessive heat during the summer of any given year.

ACKNOWLEDGMENTS

I wish to thank T. C. Emmel, H. N. Greenbaum, and D. H. Habeck, all of the University of Florida, for reading the manuscript. I am also grateful for the information and encouragement given by E. G. Munroe, Biosystematics Research Institute, Agriculture Canada, Ottawa.

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NOTES ON COMMUNAL ROOSTING OF *HELICONIUS* *CHARITONIUS* (NYMPHALIDAE) IN COSTA RICA

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Adults of the familiar neotropical butterfly *Heliconius charitonius* (L.) (Nymphalidae: Heliconiinae) form communal roosts to pass the night (Jones, 1930; Poulton, 1931). Individuals in a habitat come together to rest on a branch or dead vine and the same site may be used for roosting over a long period of time. It is known that in some species of *Heliconius*, a roost site may be used for several months (Benson, 1972). Owing to the lack of information on butterfly roosts in general and to the interest in *Heliconius* butterflies as organisms for investigations of phylogeny, population biology, microevolution, behavior, and chemical ecology (e.g., Crane, 1957; Emsley, 1963; Brower & Brower, 1964; Benson, 1971; Brown & Mielke, 1972; Ehrlich & Gilbert, 1973), we pursued a study of communal roosting in *H. charitonius* in central Costa Rica. The study consisted of documenting the membership and turnover in two different roosts in the same general region. Initially we believed that composition of the roosts was very stable in time, but as shown by our study, this turned out not to be entirely true.

Notes on the Roosts

Two roosts of *H. charitonius* were located in the rugged ridge-top terrain at "Cuesta Angel," a region of steep virgin wet forest about four km south of the village of Cariblanco, Heredia Province, Costa Rica. The first roost was discovered on 27 June 1972 in the immediate vicinity of "Site B" in the population study of Young, Thomason & Cook (In prep.); this was called the "wet season" roost (Roost A). This roost was on hanging dead creepers of *Mucuna* sp. (Leguminosae), located part way down the side of a very steep slope (Fig. 1); it was accessible for observation only by climbing down the slope on ropes and sitting on a small wooden platform constructed for this purpose. This observation deck was about 2 m beneath the roost in very dense grass.

The second roost (Roost B) was not discovered until 10 February 1973 during the variable dry season characteristic of this area. This roost was about 160 m from the first roost and situated on the crest of the ridge in thick secondary forest (Fig. 2), whereas Roost A was situated at the edge of primary virgin rain forest. Both roost sites consisted

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Fig. 1. Roost A of *Heliconius charitonius* was located at the edge of the primary growth forest on this steep slope. It was just left of the pair of *Cordia* trees, and under the shaded foliage. The observation deck is obscured by dense grass.

of dead creepers; Roost B was only about 1 m from the ground and thus very accessible for observation. We also discovered a third roost of *H. charitonius* on a very steep, dangerous slope about 200 m down the slope from Roost A; this roost was very inaccessible for study at close range, being about 20 m off the ground in a clump of vines among dense canopy vegetation. Owing to the high abundance of this butterfly at Cuesta Angel, there were undoubtedly many roosts in the area, but the very rugged terrain precluded any in-depth survey of several roosts. For these reasons, we confined our observations to Roosts A and B.

Departure of the butterflies from the roost in the morning generally occurred over a short period of time (15–45 min.) and took place either singly or in mass. The incidence of sunlight apparently triggers departure, and on overcast mornings with no rain, departures occurred at a later time. Upon leaving the roost, the butterflies insolated on the vegetation before attempting any prolonged flight. Arrival at the roost was more variable than departure, in one instance extending over a three



Fig. 2. Roost B of *H. charitonius* was on a cluster of dead creepers just to the left of center.

hour period. Light rain or overcast in the mid-afternoon hastened arrivals at the roost. On clear days, the butterflies arrived just before dusk, perhaps only coincidentally but just before the period of greatest bird activity in the area.

METHODS

The basic methodology employed was to capture, mark, and release individual butterflies either by (1) netting adults as they flew into the roost during the late afternoon and left during the early morning (as was used for Roost A), or by netting individuals throughout the day within the immediate vicinity of the roost (as was the case for Roost B). In this manner, we marked and observed butterflies associated with Roost A from 27 June–9 August 1972. During this six-week period, we visited the roost on 20 different days, despite the fact that after the tenth visit (11 July), a large branch fell next to the roost and broke some of the creepers used by the butterflies. The roost became virtually



Fig. 3. Marked and unmarked butterflies on Roost B; note marked individuals nos. 27, 34, and 45.

abandoned after this time. Our visits to this roost were generally confined to late afternoon (after 1550 C.S.T.) to observe arrival patterns of individual butterflies, and a check later that evening (usually after 2100) to make a total census of butterflies. Roost B was examined a total of *nine* different days over an *eight-week period*, ending into early April 1973 when the roost was no longer used. In this case, most observations were made early in the morning before the butterflies had left the roost. Occasionally late afternoon observations on the previous day were made in combination with the morning observations. In only one instance was an observation made of Roost B after nightfall.

We never attempted to net butterflies on the roost for marking, for fear of frightening away the insects. Twelve of the fifteen butterflies marked that were eventually seen on Roost A were initially captured in the immediate vicinity (with 15 m) of the roost, while the other three were caught a considerable distance (65–165 m) from this roost. But most of the marked butterflies seen on Roost B (31 of 42 individuals

TABLE 1. The census history of marked *Heliconius charitonius* on Roost A* (1972).

Individual No.	Age**	Date of Marking	Dates of Census***							
			June 29	June 30	July 3	July 10	July 11	July 12	July 18	July 19
2	Y	June 28	X							
3	M	June 29	X	X	X	X	X		X	X
4	M	June 29	X	X	X	X	X	X		
5	O	June 30			X		X			
6	M	June 30				X	X			
7	Y	July 1			X	X			X	X
8	Y	July 1			X					
9	M	July 3			X					
10	M	July 3			X	X	X	X		
11	Y	July 11					X			
12	M	July 19							X	
13	M	July 19							X	
14	Y	July 19							X	X
15	Y	July 19							X	
16	O	July 19							X	X

* An "X" is used to indicate the presence of an individual on the roost on a particular date when the roost was examined.

** "Y"—young or fresh; "M"—middle; "O"—old.

*** For each individual, the first entry is the first time the butterfly was seen on the roost.

first captured in the general area) had been marked before the roost was discovered, as part of a study by Thomason & Young (In prep.); all of these butterflies were captured within 30 m of the roost. Additional butterflies (11) were marked after being captured while leaving the roost.

Marking consisted of painting a small number near the center of the ventral side of each hindwing using white, fast-drying enamel paint ("Flo-paque"). Each butterfly so marked was recorded for freshness of wing condition ("age"), and only at Roost B, additionally for sex at the time of initial capture. A butterfly was always released immediately after marking. Unfortunately, the individuals of Roost A were not sexed. Resightings of marked butterflies on the roosts were made with binoculars; marked butterflies were seldom netted a second time. Usually an additional trained observer confirmed each resighting of marked butterflies on the roosts; night observations were done using a wide-beam flashlight and shining the light intermittently for short periods to minimize disturbance. For night observations on Roost A, two observers roped their way down the steep slope to the observation deck, which

TABLE 2. The census history of marked *Heliconius charitonius* on Roost B (1972-73).

Individual No.	Sex	Age	Date of Marking	Feb. 10	Feb. 12	Feb. 13	Feb. 15	Feb. 22	Feb. 24	Mar. 6	Apr. 2	Apr. 3
0	♂	M	Dec. 22		X	X			X			
2	♂	M	Dec. 22	X	X							
3	♂	M	Dec. 22		X							
6	♂	M	Dec. 22		X	X	X		X	X		
17	♂	O	Dec. 22				X	X				
18	♂	O	Dec. 22			X						
19	♂	M	Dec. 22			X						
20	♂	M	Dec. 22	X								
21	♂	M	Dec. 22	X	X	X	X	X	X	X		
23	♂	M	Dec. 22	X								
24	♂	M	Dec. 22			X						
27	♀	M	Dec. 29	X		X		X		X		
31	♂	Y	Dec. 29	X		X	X			X		
32	♀	O	Dec. 29					X				
33	♀	O	Dec. 30		X	X		X	X			
34	♀	M	Dec. 30		X	X			X			
35	♀	O	Dec. 30	X								
37	♀	O	Dec. 30	X								
39	♂	M	Dec. 30			X						
42	♀	Y	Jan. 5	X	X			X	X		X	
43	♂	Y	Jan. 6	X	X							
45	♂	Y	Jan. 6	X	X	X		X	X		X	
47	♀	Y	Jan. 6	X								
48	♀	O	Jan. 6	X		X	X					
52	♀	M	Jan. 6				X		X			

was about 25 m from the road above. It should be emphasized that it is very unlikely that observed absences of marked butterflies on the roosts at night were only apparent (i.e., not real) owing to the observers missing marked butterflies. All butterflies were coded with numbers on the hindwings, clearly visible at night. Furthermore, it was possible to get very close (within 0.5-1.5 m) of the roosts, thus eliminating inaccuracy in tabulating the marked butterflies present.

RESULTS

All of the 15 butterflies marked near Roost A were eventually spotted at least once on the roost. Although a total of 96 butterflies were marked

TABLE 2. Continued.

Individual No.	Sex	Age	Date of Marking	Feb. 10	Feb. 12	Feb. 13	Feb. 15	Feb. 22	Feb. 24	Mar. 6	Apr. 2	Apr. 3
53	♀	M	Jan. 6		X	X			X		X	
55	♀	O	Jan. 6				X					
60	♂	Y	Jan. 16				X					
61	♂	Y	Jan. 25	X	X					X	X	
62	♀	Y	Jan. 25		X	X		X				
63	♀	M	Jan. 25		X	X			X			
64	♂	Y	Feb. 10	X	X	X	X	X	X			
66	♀	M	Feb. 10				X	X	X	X	X	X
67	♀	Y	Feb. 10			X		X	X		X	
68	♀	Y	Feb. 10		X	X	X					
69	♂	Y	Feb. 10		X	X		X	X	X		
71	♂	Y	Feb. 24							X		
75	♀	Y	Feb. 24							X		
80	♂	M	Mar. 6							X		
81	♀	Y	Mar. 6							X		
82	♂	Y	Mar. 10								X	
83	♀	Y	Mar. 10								X	
1*	♂	Y	Jan. 16							X		
5*	♂	Y	Jan. 16							X		
11*	♀	Y	Jan. 17		X							
28*	♂	Y	Feb. 21					X				
89*	♀	Y	Feb. 11		X	X	X	X	X	X	X	X

* These last 5 entries are butterflies originally marked at other sites: Nos. 1*, 5* and 11* were marked at Site B in the study of Young, Thomason, & Cook (In prep.), about 160 m from Roost B, in the immediate area of the original Roost A. Nos. 28* and 89* were marked at Site D (*op. cit.*), about 150 m below Roost B, midway down the side of the ravine. Please note that the butterflies entered here are different from those in Table 1.

in the immediate vicinity of Roost B, only 42 were seen at least once on this roost. Of these 42 individuals, 19 were females and 23 were males, suggesting a sex ratio of 1:1 for roost membership with time. For Roost A, between 27 June and 10 July, there was an average of 13 butterflies on nights of observation. After 10 July, nightly attendance dropped greatly to an average of about 2 butterflies, beginning the night of 11 July which is the date the branch fell and destroyed some of the creepers used for roosting. There were no butterflies present on the roost for the last two dates of observation in early August. For Roost B there was an average of about 25 butterflies on the roost for the first seven nights of study, and for the last two nights, there were only five butterflies on each night.

TABLE 3. Mean percentage of resightings per marked butterfly over five or more census dates.*

Age Class	♀ ♀				♂ ♂				Total			
	N	\bar{x}	\pm	S.E. (%)	N	\bar{x}	\pm	S.E. (%)	N	\bar{x}	\pm	S.E. (%)
Roost A												
Young									3	32.0	\pm	24.6%
Middle									5	59.0	\pm	22.1%
Old									1	33.0		%
Total									9	47.2	\pm	25.5%
Roost B												
Young	7	41.2	\pm	28.3%	10	35.5	\pm	-3.2%	17	37.9	\pm	25.6%
Middle	6	44.4	\pm	14.4%	10	25.5	\pm	22.2%	16	32.6	\pm	21.7%
Old	6	20.4	\pm	13.5%	2	16.6	\pm	5.6%	8	19.4	\pm	12.1%
Total	19	35.6	\pm	23.0%	22	29.3	\pm	22.6%	41	32.2	\pm	23.0%

* For those butterflies present in the population as marked individuals for 5 or more census dates. Mean percentage of resightings per marked butterfly is the average percentage that a given age group and sex were resighted on the roost.

Marked butterflies behaved identically to unmarked butterflies when on the roost (Fig. 3). Tables 1 & 2 summarize the census histories for all marked individuals of *H. charitonius* observed at least once on Roosts A and B respectively. It is striking that the temporal pattern of attendance is variable among individuals, despite large interruptions between dates of census. For example, 19 of the 42 marked butterflies seen on Roost B were seen only once, although 6 of these only were caught near the end of the study period (i.e., 6 March and 2 April). There is no particular pattern with respect to age as indicated by relative condition of the wings; "young" individuals are equally residential as "middle" individuals (Table 3). If we assume that the number of dates of observations on the roosts is sufficient for detection of temporal patterns of visitation over relatively short periods of roost existence, then it appears that roost membership from day to day is variable. Of the 69 butterflies marked at Site A by 10 February, 36 of these were seen on the roost at least once; of these 36 butterflies, 23 were seen one to three times on the roost while 13 were seen four to seven times (36%). If we define residentiality for an individual butterfly as it being present for 50% or more of the census dates, then 36% of the marked butterflies on the roosts were residents. Also, at Roost B, five individuals were marked at two different areas about 150 m from the roost (nos. 1, 5, 11 and 28 at one and no. 89 at another location). Of these, only no. 89 was seen more than once, becoming a highly residential member of the

roost (Table 2). For Roost A marked butterflies, individuals nos. 3, 4, 7 and 10 showed high residentiality (Table 1).

The average number of resightings for each individual on the roost (Table 3) is another useful statistic for estimating residentiality or lack thereof. There is a general tendency for females to be residential slightly more than males, although this difference was only statistically significant for the "middle" category of both sexes, as indicated by a *t*-test ($t = 1.85$ for 14 degrees of freedom at $p = .05$) for the Roost B data. Tests of significance for differences in residentiality with increasing age within each sex were inconclusive, although it appears that older butterflies are resighted fewer times than young ones.

DISCUSSION

It is not known why individuals of *H. charitonius* roost communally. It is known that the butterflies are capable of detecting yellow color (Swihart, 1971), and this could be the appropriate visual mechanism causing adults to be attracted to one another during the late afternoon, the "capacity for sociability" of Beebe (*in* Jones, 1930). It was frequently observed that the butterflies arrive at a roost in small groups as well as singly, so individuals can be "recruited" to a roost site through visual contact with other individuals in the areas. Benson (1972) noted that flying aggregations of *H. erato* (L.) form during the late afternoon just before communal roosting.

In dense populations of *H. charitonius* such as the one at Cuesta Angel, there are undoubtedly many roosts within the area occupied by the adult population, and the prolonged absence of some marked butterflies seen at times on roosts, especially young butterflies, could be indicative of (1) instances of these butterflies sleeping singly away from the roost, or of (2) a high frequency of exchange in which these individuals associate with a number of roosts in the area, or leave the home area completely for a period of time, as was the case for four of the last five entries in Table 2. Communal roosting is a known social behavior pattern of *H. charitonius* (Jones, 1930) and our data suggest that the fidelity of individuals to a roost may be high. The pattern is one of some individuals being very residential at a roost, while other individuals are considerably less faithful; such a pattern, that correlates neither with sex nor age to any convincing degree, may be indicative of genotypic differences among individuals. In this context, it would be very interesting to determine if highly residential individuals with respect to roosting are also individuals that have high home range tendencies or low mobility (Benson, 1971). Despite the fact that many adults may exhibit home range behavior within the vicinity of Roost

B (Young, Thomason, & Cook, in prep.), the failure of many of these marked butterflies (54/96) to show up on the roost during the study period, plus the large number of individuals seen only once on the roost, suggests further that multiple roosts occur within an area of home range movement. Jones (1930) found substantial exchange of individuals among roosts of *H. charitonius* in Florida. As in our study in Costa Rica, both Jones (1930) and Poulton (1931) also observed large roost size for this species; roost size was close to 30 butterflies in some cases. The size of roosts of *H. charitonius* seen in the present study were much larger than the roosts of *H. erato* observed in Costa Rica by Benson (1972).

However, the greatly reduced percentage of resightings of "old" marked butterflies suggests that the mortality of older individuals also contributes to the failure of butterflies to be observed consistently on the roosts. In a capture-mark-release population study of the butterfly here, conducted over several successive months, it was found that old individuals are the ones recaptured the least number of times, and they tend to disappear within a very short time (Young, Thomason, & Cook, in prep.). In those instances where a marked butterfly is seen on a roost infrequently at long intervals it is difficult to explain why this is the case since there were long gaps in the nightly schedule of observations. It may be a regular habit of the butterflies to spend most of their time on a given roost, but due to the presence of a large number of roosts in the area, individuals occasionally transfer to another and then perhaps transfer back to their original roost. But since observations were not continuous and not on several roosts simultaneously, it is not possible to interpret the data further. More field study is clearly needed to distinguish among these alternative explanations of absences of marked butterflies from roosts. It is clear from the data that butterflies may be absent from roosts and further studies are needed to explore the reasons why this is so.

Sexual behavior was not observed for individuals on roosts, and judging from the condition of adults, it is likely that both mated and virgin females partake in roosting with males; the reduced amount of sunlight at the time of roost formation probably precludes any courtship activity. Poulton (1931) noted that individuals of both sexes of *H. charitonius* roost together, with an approximately 1:1 sex ratio.

Some recent studies (Turner, 1971; Ehrlich & Gilbert, 1973; Benson, 1972; Thomason & Young, in prep.) have demonstrated that adults of some species of *Heliconius* exhibit home range movements. Both home range behavior and communal roosting limit the tendency for indi-

vidual butterflies to move out of some portion of the habitat containing sufficient resources. The population in which individuals exhibit home range movement forms one or more roosts, and exchange among the roosts may be high, depending upon (1) dispersal tendencies of different genotypes, (2) population density, and (3) the spatial and temporal distribution of adult resources (preferred flowers—cf. Brown & Mielke, 1972). Ehrlich & Gilbert (1973) observed changes in the home range movements of individuals of *H. ethilla* Godart on Trinidad when an important food plant was accidentally cut down during their experiment.

It has recently been argued that the combined characteristics of limited home range movement and communal roosting in *Heliconius* are found in unpalatable species (Benson, 1971). Since *H. charitonius* is phylogenetically close to *H. erato*, a highly unpalatable and mimetic species in some localities (Brower & Brower, 1964), it is strongly suspected that *charitonius* is also unpalatable (W. W. Benson, pers. comm.).

Even though some individuals in an area exhibit substantial residentiality at a roost (Table 2), there must be a complex of environmental factors that makes roosts temporary to some degree. An accidental damaging of perching sites may result in butterflies abandoning a roost site completely (Roost A on 11 July). One of us (A.M.Y.) has seen a small group of toucanets shake creepers containing a roost during the late afternoon, resulting in many butterflies settling individually on nearby vegetation and not returning to the roost that night. Also, the occasional appearance of individuals on the roost that were marked considerable distances away (nos. 1, 5, 11, 28 and the highly residential no. 89) could be the result of accidental passive displacement by strong winds and even of attempted predatory attacks in the usual home range area of such individuals. However neither of these events were observed to take place when observations were being conducted. If there are large differences in the size of the assumed home ranges of individuals, this in turn could influence residentiality: individuals with large home ranges may show a greater tendency to be transient among different roosts from night to night. It is clear, though, from our preliminary study, that communal roosting in *H. charitonius* in a dense mountain population in Costa Rica reflects the tendency for many butterflies to be residential for a given roost, even over relatively small distances in the habitat between roosts. Further studies should document the locations of other roosts and measure individual exchange among roosts and the relation of such movement to home ranges. But it is also evident that other species of *Heliconius* in similar or the same habitats exhibit very different adult

movement behavior: at Cuesta Angel, *H. cydno* is found in the same habitats as *H. charitonius* but it neither exhibits communal roosting nor home range behavior of the type seen in the latter species (Young, 1973).

SUMMARY

(1) Using the method of capture, mark, and recapture, the composition and individual residentiality (or turnover) of two roosts of the neotropical butterfly *Heliconius charitonius* L. at one mountain locality in central Costa Rica were investigated. One of the roosts was studied during the wet season (June–August 1972) and the other during the following dry season (February–April 1973). The roosts were situated about 160 m from one another, though at different times.

(2) Our working hypothesis was that the composition of a roost should be stable through time, with the exception of occasional new recruits through eclosion in the area. In general, we found this to be the case, but with some evidence of considerable transiency among some individuals on each roost. Thus roosts of this butterfly are less stable than usually assumed in the literature for *Heliconius*.

(3) Based on our observations of the larger roost, we found that about 36% of the marked butterflies seen on that roost which were marked early in the study in fact returned on 50% or more of the nights of observation, suggesting a high degree of residentiality among certain individuals. The degree of residentiality could not be correlated in any convincing way with sex or age of individuals. However, there is a tendency for old butterflies to disappear faster from roosts, suggesting they have died. Owing to large gaps in the observation records, it is not possible to confirm the suggestion that *H. charitonius* individuals spend most of their time at one roost but occasionally transfer to other roosts in the area, and then perhaps transfer back to the original roost.

(4) The temporary component of roost membership over short periods of time (weeks) is very likely due to several factors including (a) the tendency for certain individuals to spend the night at different roosts, or singly away from the roost, but in the general area, (b) accidental wanderings into the vicinity of other roosts, and (c) tremendous variation in the size of home ranges assumed to be possessed by individual butterflies.

ACKNOWLEDGMENTS

This research is a by-product of National Science Foundation Grant GB-33060. We thank Roger Kimber, Susan Parry, and Eleanor W.

Thomason for field assistance. The late Gonzalo Gonzalez Serrano of Cariblanco donated the material and tools for construction of the observation deck. The comments of an anonymous reviewer were most helpful.

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GENERAL NOTES

DATA CORRECTIONS ON *LETHE APPALACHIA LEEUWI*
(SATYRIDAE)

Errors were found by Roderick R. Irwin to occur in our description of *Lethe appalachia leeuwi* (Gatrelle & Arbogast 1974, J. Lep. Soc. 28: 359-363). The errors he found relate to the incorrect copying by us of the labels on his specimens. We herein correct these errors and give the proper label data for the paratypes concerned, which are all in the Illinois Natural History Survey collection except for the specimen collected by Norm Seaborg.

The 1974 data were given as: "Cass County: . . . 1 male and 1 female, 7 July 1971; 2 males, 9 July 1971 (*leg. R. R. Irwin*); 1 male (abdomen missing), 1 July 1973 (*leg. M. G. Seaborg*)."

This should have read as follows (corrections in boldface): "Cass County: . . . 1 male, 7 July 1971; 2 males, **6** July 1971 (*leg. Irwin Leeuw*); 1 female, 7 July 1973 (*leg. R. R. Irwin*); 1 male (abdomen missing), 1 July 1973 (*leg. N. G. Seaborg*).

During our continuing study of North American *Lethe* we have noted the confusion which exists among the species in the literature. *Lethe eurydice* (Johannson) and *leeuwi* are best told apart superficially by the markings of the hind wings below (ventral). We would like to point out, without going into detail, that the only "popular" book in which the ventral surface of either *eurydice* or *appalachia leeuwi* is figured is that by Klots (1951, A Field Guide to the Butterflies Houghton Mifflin: Boston). In that book on plate 10, fig. 4 is the photograph of a specimen from Sharon, Conn.; the specimen is labeled as *Lethe eurydice*. It is in fact a specimen of *appalachia leeuwi*, and a very typical one at that. This is pointed out here to help stop some of the confusion that may arise between *eurydice* and *appalachia leeuwi* due to the recent description of the latter.

It is well to mention here also that the type of *leeuwi* has been placed in the Allyn Museum of Entomology, Sarasota, Florida.

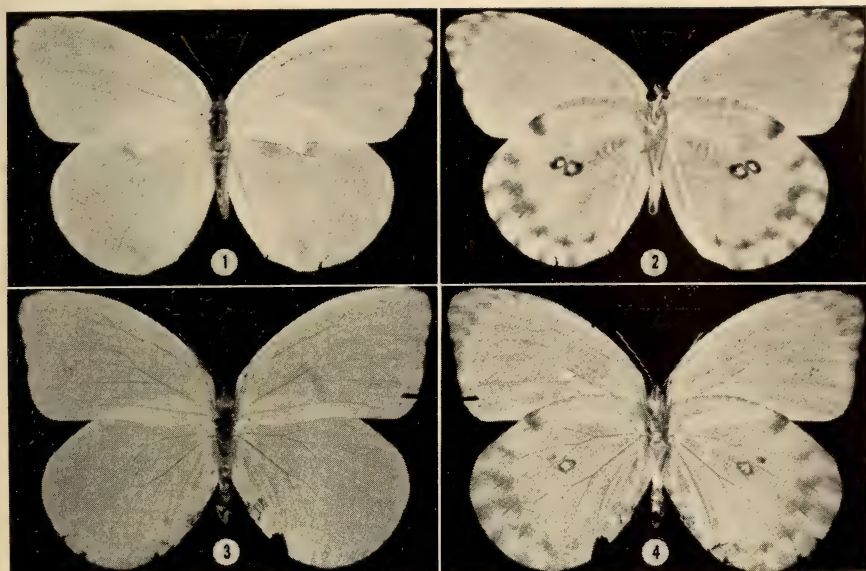
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NOTES ON THE RARE MEXICAN PIERID *PRESTONIA CLARKI*
(PIERIDAE)

Schaus (1920, Proc. U. S. Natl. Mus., 57: 109) described *Prestonia clarki* from a single Mexican female. This specimen in the National Museum of Natural History long has been the only one known, leading Brown (1929, Amer. Mus. Novitates, [368]: 13) to consider it a female form of *Phoebis argante argante* (Fabricius), a conclusion he (Brown, 1933, Amer. Mus. Novitates, [653]: 5) later reversed. Since that time *Prestonia* has remained in the literature as a separate genus including just one rare species and something of an enigma in the *Phoebis* group. The male genitalia are diagnostic in assigning species to their proper genera, and the unique female type allowed no such placement.

Dr. Tarsicio Escalante of Mexico, D. F., Mexico has accumulated perhaps the finest collection of Mexican Lepidoptera ever assembled. Not surprisingly he had specimens of both sexes of *P. clarki* taken at Presa Mixtequilla, Tehuantepec, Oaxaca. He presented two pairs of these specimens to the Allyn Museum of Entomology, and they form the basis of the redescription which follows.



Figs. 1-4. *Prestonia clarki* Schaus: 1-2, ♂, upper (1) and under (2) surfaces; MEXICO: OAXACA: Presa Mixtequilla, Tehuantepec (Allyn Museum photos 122774-3 & 4); 3-4, ♀, upper (3) and under (4) surfaces; same data (Allyn Museum photos 122774-5 & 6).

Male (Figs. 1-2): Head, thorax and abdomen centrally black above, laterally olive-yellow and ventrally yellow-orange. Palpi bright yellow-orange, olivaceous at the tips. Antennae short (less than $\frac{1}{3}$ length of forewing costa), brown above, olive-yellow below; tips yellow. Legs yellow, bright pink along outer margins.

Upper surface of wings orange-yellow, slightly reddened toward forewing costa and strongly so in distal half of hindwing, unmarked except for gray marginal triangles at ends of forewing veins and discal markings of the under side of the hindwing showing through weakly.

Under surface of forewing pale orange, grading to yellow marginad, and unmarked except for some rusty scaling forming an indistinct subapical band, rust scaling at ends of apical veins and a narrow, faint pink marginal line. Hindwing below also pale orange lightly overscaled with rust, two white spots outlined with purplish-brown near end of cell, a discal band of poorly defined purplish-brown spots from the middle of the costa to Cu_2-2A and some purplish-brown spots at ends of veins from Rs through Cu_2 .

The lengths of the males of the forewings at hand are 30.5 and 32.0 mm.

Male genitalia as illustrated (Fig. 5), more closely resembling those of *Rhabdo-dryas* and *Aphrissa* than those of *Phoebis* (see below for discussion).

Female (Figs. 3-4): Closely resembles the male, but the ground color of all wings and surfaces somewhat yellower and duller.

The lengths of the forewings of the Presa Mixtequilla females are 32.0 and 33.0 mm.

Superficially *P. clarki* most closely resembles *Phoebis agarithe* or *argante* above, but there the similarity ends. The under surface pattern is not that of *Phoebis*.



Fig. 5. *Prestonia clarki* Schaus: ♂, genitalia (slide M-2596 [Lee D. Miller]); MEXICO: OAXACA: Presa Mixtequilla, Tehuantepec.

Aphrissa has a more or less immaculate under surface, and the median line down both wings that is characteristic of *Rhabdodryas* is not shown in *Prestonia*.

The male genitalia do not conform to the patterns shown in the three other genera, either. Examples of the genitalia of *Phoebis*, *Aphrissa* and *Rhabdodryas* are given by Brown (1929: figs. 8-10, 5-7 & 35-37, respectively). Comparison of these figures with the one given here for *P. clarki* will show the following: (1) the uncus is closest to that of *Phoebis* or *Rhabdodryas*; (2) the valvae, while reminiscent of *Rhabdodryas* with regard to the terminal projection, are actually structurally closer to those of *Aphrissa*; (3) the penis is closest to that of *Rhabdodryas*, but is not very dissimilar to that of *Phoebis*; (4) the saccus is long, as in both *Aphrissa* and *Rhabdodryas*, but is more robust than in either genus, thereby tending toward that of *Phoebis*.

The intermediate condition of the genitalia in *Prestonia* suggests that either our concept of four genera is wrong or that *Prestonia* lies near the base of the *Phoebis* group. We are inclined to retain the four genera. In any event, none of the four genera can be equated with the Old World *Catopsilia* (see Brown, 1929: figs. 2-4 for the genitalia of this genus) which apparently is not even a rhodocerine. While it is intriguing that an annectant form should occur in southern and western Mexico, the situation is by no means unique: the strange papilionid *Baronia brevicornis* Godman and Salvin is from just this area.

P. clarki was considered in a paper by Dra. Leonila Vazquez G. (1955, An. Inst. Biol., 26: 477-491). This paper was not known by either of us at the time of submission of the present paper; fortunately Dra. Vazquez's conclusions were substantially the same as ours, though she considered *Prestonia* to be a subgenus of *Phoebis*, rather than a separate genus.

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ABERRANT *CHLOSYNE LACINIA* (NYMPHALIDAE) FROM
CENTRAL TEXAS

Chlosyne lacinia (Geyer) is an extremely variable nymphalid butterfly. The phenotype present in central and southern Texas is *adjutrix* Scudder, a form with brownish-black ground color and various spots and bands which are white, yellow, orange-brown and orange-red.

An aberrant specimen of *adjutrix* was collected on 18 October 1973 at the Brackenridge Field Laboratory of the University of Texas at Austin within the city limits of Austin, Travis County. The normal-sized adult, believed to be a female (abdomen is missing from the specimen), was feeding at a flower garden with normal *adjutrix*, which were common at the time. This melanic individual is almost totally brownish-black. The normally prominent median orange-brown band of the hindwing is represented only by a small red-orange anal spot on both dorsal and ventral surfaces. Submarginal spots are represented by barely-visible dark smudges which appear shadowy. Pin-prick sized post-median spots of the hindwings are slightly subnormal in size. Orange pigmentation on legs and basal costal margin of VHW is normal.

It is noteworthy that the only two constant wing pattern characteristics that Higgins (1960, Trans. Roy. Ent. Soc. London 112: 381-467) found for this extremely variable species are present in this specimen: 1) orange streak at basal costal margin of VHW and 2) red-orange anal spot on VHW. Although some populations of *lacinia* are normally melanic (*crocale* Edwards in southwestern North America and *quehtala* Reakirt in Middle and South America), this specimen is the extreme melanic form known for *lacinia*.

Another aberrant form was collected on 15 October 1969 in Bexar County, Texas (Farm Road 1518, 3.2 km W of U.S. 281). This female was apparently searching for oviposition sites on *Verbesina encelioides* Cav. (Compositae). It has normal pigmentation except that all spots on DFW and VFW are white; spots are normal in size, shape, number and position. The modified color in the bands and spots of the forewing and retention of normal hindwing pigmentation gives this individual a resemblance to nominate *lacinia* (see Godman and Salvin, 1882, v. 38, pl. 19, fig. 6-7). Comstock (1931, The Butterfly Book, rev. ed., pl. 18, fig. 10) also illustrates nominate *lacinia* (labeled as *C. janais* (Drury)). It differs in the retention of post-basal and sub-median spots. There is no break in my specimen in the median DFW band as in nominate *lacinia*.

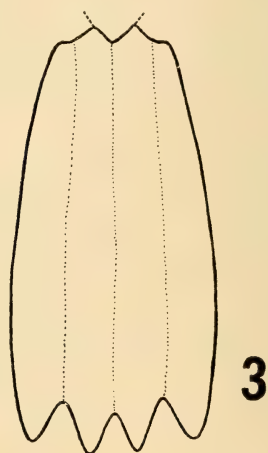
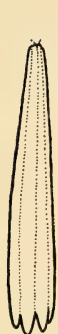
A second female specimen with white forewing spots was collected at the Brackenridge Field Laboratory on 24 September 1971 as it fed at flowers of *V. encelioides* along the banks of Town Lake (Colorado River) about 400 m from the collecting site of the melanic specimen. Forty-seven normally pigmented adults were reared from eggs laid by this wild-mated female.

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A FIELD-CAPTURED *ASTEROCAMPA CLYTON* (NYMPHALIDAE)
WITH ABERRANT SCALATION¹

An aberrant male of *Asterocampa clyton* (Boisduval & LeConte) (Nymphalidae) was collected about 0.5 mi. N of Hoges Chapel, Giles County, Virginia, on secondary road 613, on 3 August 1967. This aberration involves a malformation of the wing

¹ Florida Agricultural Experiment Station Journal Series No. 4803.



Figs. 1-3. *Asterocampa clyton*: 1, dorsal aspect of male contrasting the aberrantly-scaled right hindwing with the normal wings (composite photograph); 2, wing scale from aberrant hindwing, upper surface; 3, wing scale from normal frontwing, upper surface.

scales of the upper and lower surfaces of the right hindwing, giving the wing a superficially bare appearance (Fig. 1). The scales are pigmented so that the normal wing pattern is clearly visible, but it appears as a tint in the wing membrane. The scales are narrowed and underdeveloped (Fig. 2) when compared to the normal fan-shaped wing scales of the other three wings (Fig. 3). The "hairs" and venation of the aberrant wing appear to be normal, but the wing membrane is contracted, pulling the veins toward each other, thus giving the aberrant wing the appearance of being slightly reduced in size.

Dornfeld ("1970"(1971), J. Res. Lepid. 9: 25-28) reported a field-captured aberration of *Anthocaris sara* Boisduval (Pieridae) showing a similar type of wing-

scale deformity involving all four wings. The aberration involved extensive loss of scales, with those remaining being restricted largely to the veins. Also the scale pockets were abnormal, a fact to which Dornfeld attributed the loss of scales. The aberration of *Asterocampa clyton* involved no apparent loss of scales. Both specimens, however, exhibit the same type of scale aberration (narrowed and elongated rather than fan-shaped, and having the distal prolonged margins ill-defined, reduced or lacking). Dornfeld observed that the individual of *Anthocaris sara* displayed weak flight, which was not the case with the individual of *Asterocampa clyton*. Dornfeld speculates that this aberration may have a low survival rate due to its weak flight pattern, and thus it has not been collected more frequently in the field.

Restricted deformities such as that displayed by the specimen of *Asterocampa clyton* are probably not gametic in origin, and thus survival rate would have no effect on the frequency of occurrence of such aberrations. Thus, a low frequency of occurrence of scalation aberrations in the field would persist, and the chances of encountering such an aberration would remain more or less constant with time. Apparently scalation aberrations are rare in nature and thus encounters are rare. However, chance field-capture of the restricted scale-deformed specimen of *Asterocampa clyton* has shown that scalation aberrations do occur occasionally; thus, additional field-captured specimens possessing scalation deformities should appear in the future.

The specimen of *Asterocampa clyton* is located in the personal collection of the author.

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ASSOCIATION OF ANTS WITH OVIPOSITING *LYCAENA RUBIDUS* (LYCAENIDAE)

Many species of Lycaenidae associate to varying degrees with ants (Ford, 1957, Butterflies, Collins: London; Malicky, 1970, J. Lepid. Soc. 24: 190-202; Owen, 1971, Tropical Butterflies, Oxford: Clarendon Press). While some ant-lycaenid interactions have been observed in detail, many associations are known from scanty data. This paper reports another ant-lycaenid association, the first such instance reported for either species involved.

Adults of *Lycaena rubidus* (Behr) were observed 22 July 1968 at Maverick, el. 2377 m, Apache County, Arizona. The butterflies were common at the abandoned townsite in a grassy meadow bisected by Pacheta Creek. Many female *L. rubidus* exhibited oviposition behavior at wild-rhubarb, *Rumex hymenosepalus* Torr. (Polygonaceae). Each such female hovered near a plant, and then alighted on one of the leaves. She then walked down the leaf toward the base of the plant. Upon reaching a height about 2-8 cm above ground, she laid an egg, which fell to the substrate, sometimes bouncing on one or more leaves of the plant on its way. The ground was covered by a sparse layer of dead plant matter. After laying each egg, the female then walked back out toward the top of the plant. She then either sat for a minute or more before going back down to lay another egg, or flew to another plant. Each egg was laid singly.

Small black ants, *Formica altipetens* Wheeler, were observed on the ground litter beneath, as well as on, some of the *Rumex* plants. When one butterfly laid an egg,

one of the ants on the ground litter changed the direction of its movement and ran about 2 cm from its former position over to the egg. The ant grasped the egg and carried it off. This phenomenon was then observed on two more occasions.

For the next 30 minutes, a female *Lycaena rubidus* was followed as she oviposited at three nearby (within 1 m) plants. She laid 14 eggs, 5 of which were picked up by ants on the ground. In two instances, single ants on the plants followed the butterfly as she descended the plants' leaves. In both instances the ant seized the egg as soon as it emerged from the butterfly and before it fell to the ground.

Two other female *L. rubidus* were subsequently observed as they oviposited in a similar manner. Several times eggs were picked off the ground and carried away by single ants. Three times ants seized eggs as soon as they were extruded by the butterfly.

The ants' behavior in following an ovipositing female butterfly suggests that the ants have the ability to anticipate oviposition. Ants were not observed to enter their nest(s) with butterfly eggs, and were not followed more than a few cm from the base of a plant. Whether these observations indicate predation or a more complex association is not known. The life history of *L. rubidus* is unknown, except for a report by Brown, Eff, & Rotger (1955, Proc. Denver Mus. Nat. Hist. 5: 152) that larvae were found feeding on *Rumex* sp. in Colorado. *Formica altipetens* was found tending aphids in North Dakota by Wheeler & Wheeler (1963, The Ants of North Dakota, Grand Falls: Univ. N. D. Press).

Ant specimens were deposited in the collections of Northern Arizona University and the National Museum of Natural History, and butterfly specimens in those of the Museum of Northern Arizona and the author.

ACKNOWLEDGMENTS

These observations were made during a biotic survey of the White Mountains region of eastern Arizona conducted by the Museum of Northern Arizona, Flagstaff. I thank: W. B. McDougall for identifying the *Rumex*; D. R. Smith for identifying the ants; C. D. Johnson and R. I. Sailer for assistance; and L. E. Brown, C. R. Carroll, J. R. Heitzman, D. H. Janzen, K. Roever, and W. H. Wagner for reviewing the manuscript.

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RECORDS OF *CALEPHELIS WRIGHTI* (RIODINIDAE) IN SOUTHWESTERN ARIZONA

McAlpine (1961, in Ehrlich & Ehrlich, How to Know the Butterflies) and Emmel & Emmel (1973, The Butterflies of Southern California) include western Arizona in the range of *Calephelis wrighti* Holland. No specific localities have been published, and inquiries to experienced regional collectors and museums yielded no Arizona records. Eventually, David L. Bauer kindly provided the following records, which do confirm the presence of *C. wrighti* in southwestern Arizona:

ARIZONA: Yuma County. Gila Mountains, Telegraph Pass (1980') 11-xi-1946 (1 ♂ *ex larva*), 20-iii-46 (1 ♂), 21-ii-47 (1 ♀). Dome Canyon 22-x-46 (1 ♀), 11-ii-47 (1 ♂ 3 ♀), 24-ii-47 (1 ♀), 19-iii-47 (1 ♂). Sheep Hole Canyon 9-iii-47 (2 ♂). Castle Dome Plain, 18-ii-47 (1 ♀), 25-iii-47 (3 ♂ 3 ♀). Castle Dome Mountains, Castle Dome Canyon 18-ii-47 (1 ♂), 13-iv-47 (2 ♂ 3 ♀), 23-iv-47 (1 ♀ *ex larva*).

Bauer also provided a single record from California:

CALIFORNIA: Imperial County. Near Laguna Dam, Colorado River, 16-v-46 (1 ♀).

Approximate elevations above sea level were from 200' at the Colorado River to 2500' in the mountain canyons (ca. 60–770 m). The larval foodplant, *Bebbia juncea* (Compositae), is locally common in this region in rocky desert canyons and washes.

Some earlier Arizona records of *C. wrighti* may refer to the somewhat similar *Calephelis arizonensis* McAlpine, described in 1971. The nearest known locality for that species to the Gila Mountains is the Baboquivari Mountains, about 155 air miles southeast. Due also to the nebulous use of the name *Calephelis australis* Edw. by early authors, it is not always known whether their records refer to *C. wrighti* (called *australis* by Comstock, 1928, Bull. So. Cal. Acad. Sci. 27: 80), or to *Calephelis nemesis* Edw., which also occurs near Yuma. McAlpine (1971, J. Res. Lep. 10: 28) considers *australis* a subspecies of *nemesis*.

The author has been unable to relocate *C. wrighti* at the above localities in several trips in 1973 and 1974. However, the butterfly is probably of rather erratic and sporadic occurrence in the lower Colorado River region, one of the most arid and seasonally torrid areas in the Western Hemisphere.

ACKNOWLEDGMENTS

I thank P. H. Arnaud, H. K. Clench, L. M. Martin, K. Roever, F. T. Thorne, and J. W. Tilden for information.

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BOOK REVIEWS

BIOLOGY, ECOLOGY, AND HOST SPECIFICITY OF MICROLEPIDOPTERA ASSOCIATED WITH *QUERCUS AGRIFOLIA* (FAGACEAE), by Paul A. Opler. 1974. University of California Press, v + 83 p., illus. + 7 plates. Price \$4.25 (U.S.).

This publication is a major contribution to our knowledge of the microlepidopterous fauna of the oaks of California. Emphasis is on the bionomics of 35 species of Microlepidoptera associated with the leaves of coast live oak. Also included is information in regard to the occurrence of these insects, and related described and undescribed species, on 18 other Fagaceae in California.

There is an initial consideration of the taxonomic status of the Microlepidoptera associated with coast live oak and other Fagaceae. This is followed by a treatment principally of the phenology of the more abundant California Fagaceae. Most of the volume is devoted to the biology of the coast live oak associated Microlepidoptera, including sections on general biology, and more specific information on the adults, larvae and pupae. Some illustrations of the leaf mines of several species and a number of diagrammatic figures representing oviposition sites are included. There are also intriguing sections on life cycle adaptations, host specificity, and speculation on the evolution of Fagaceae-associated Microlepidoptera and their hosts.

The plates that complete the volume consist of a series of photographs mostly of mines, other shelters, and eggs of several Microlepidoptera on their host. It is somewhat disappointing that the mines, etc. of only 14 of the 35 species associated with coast live oak are illustrated. Also, unfortunately, a photograph depicting a typical collecting site is included that presents, mostly because of its small size, a distorted, inadequate view of coast live oak and its surroundings. These deficiencies in the plates are minor, however, and, as a whole, the photographs are of good quality and add materially to the publication.

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BRITISH TORTRICOID MOTHS, COCHYLIDAE AND TORTRICIDAE: TORTRICINAE, by J. D. Bradley, W. G. Tremewan and Arthur Smith with additional color illustrations by Brian Hargreaves. 1973. Ray Society, c/o British Museum (Natural History), Cromwell Road, London S.W. 7, England, i-viii + 251 p., 51 figures, 47 plates (26 in color). Priced £11.50 (\$27.60 U.S.).

This splendid volume will undoubtedly rank as one of the outstanding contributions to the contemporary study of Microlepidoptera, and the authors and illustrators alike are to be congratulated. This will serve not only the non-specialist, at whom it is directed, but also a large segment of the professional community; and it will be useful on the continent as well as in the British Isles.

The authors are careful to describe pitfalls in the consideration of coloration and pattern. Following this there is a discussion of variation and the general characteristics of the Tortricoidea, including imago, genitalia, ovum, larva and pupa, with excellent structural illustrations. Next are discussions of biology, collecting and preparation of specimens, dissection and preparation of genitalia, preservation of larvae and pupae, phylogeny and nomenclature and synonymy.

Preceding the main body of the work is a key to the Tortricoidea, followed by a systematic list of the Cochylidae (Phaloniidae) and Tortricidae.

In the main body of this study the Cochylidae are dealt with first. Under each

species are included synonymy, description, comments, biology including ovum when known, larva, pupa, and imago; and distribution. At the end of the text to this family are 8 black and white plates illustrating the work of the larvae. The treatment of the Tortricidae, which follows, is consistent with the above, and for this family there are 13 black and white plates showing work of various larvae.

A real treat follows: 26 beautiful colored plates! Every species is illustrated and the colored drawings by Brian Hargreaves and Arthur Smith leave nothing to the imagination.

The list of larval foodplants and the excellent bibliography terminate this volume.

J. F. GATES CLARKE, *Department of Entomology, National Museum of Natural History, Smithsonian Institution, Washington, D. C. 20560.*

NOTES AND NEWS

Recent Letters

Dear Mr. Godfrey:

Dr. Lee D. Miller's review of "Butterflies of the World" by H. L. Lewis in the "Journal of the Lepidopterists' Society" (Vol. 28, No. 2, 31 May 1974, p. 178-179) was a review of a professional. As an amateur, the book has been of tremendous value to me. Granted there may be some errors, but if professionals look close enough, they will find some errors in every book, just as Dr. Miller has in every book review he has made.

Since there are hundreds of amateurs like myself who are members of The Lepidopterists' Society, they too should be considered. Although there may be some technical errors in the book, the author should not be criticized. I challenge Dr. Miller's comments "Perhaps one expects too much from a book that purports to be what this one does, but it simply is not a good book." That may be Dr. Miller's opinion, but I think it is an excellent book and I highly recommend it for all amateurs. I might add that of all the many books in my library, this one gives the most complete information on more worldwide species in one volume, and should be a valuable help to amateurs and professionals alike.

There are too few modern books on Lepidoptera published today. Authors should be encouraged instead of discouraged. There is every evidence that author Lewis put forth much time and research, and I congratulate him and the publishers for a job well done.

RAY W. BRACHER

The Editor:

Lee D. Miller's forthright review of H. L. Lewis' "Butterflies of the World" prompts me to comment. He remarks, "This book is fairly good and accurate for the Old World and quite poor and out of date for the New." I would say he is as rusty on the southern fauna as I on the palearctic after fifty years residence south of the line.

Asked by a junior colleague to resolve f.37 on plate 187, which purports to show *Motasingha atralba*, I was induced to undertake a quick check of the Indo-Australian plates and text, and ended with three foolscap pages of corrections. I think the Old World portion of the book is as "poor and out of date" as the New World portion.

During 1942-43 A. S. Corbet and G. Talbot, both working on the British Museum material, with the advantage of having the Boisduval, C. and R. Felder, Moore, Butler and other types together for comparison, gave us for the first time a comprehensive revision of *Euploea*. Admittedly this is a difficult genus. The author [Lewis] of this book, claiming to have worked in the same institution, ignores their publication. Plate 154, f.15 named *E. darchia* is subsp. *hopfferi* C. & F. Felder from Aru, and is very different from typical *darchia* Macleay described from Darwin, Australia. In fact Lewis does not even mention Australia as a locality for the species. F.16 on the same plate is *E. deheeri* Doherty from Sumbawa; it is a subspecies of *E. modesta* Butler from Burma-Thailand. So here Lewis is neither consistent nor correct. He uses the species name for f.15 (*darchia* for what is subsp. *hopfferi*) and the race name for f.16 (*deheeri* for what is *modesta* subsp.) having previously on the same plate, (f.5) used *arisbe*, a race name, for the subspecies of *darchia* from Timor!

Proven synonyms have been revived as though the work of other authors had never been published. Plate 154, f.18, *E. diana* is a synonym of *E. algea horsfieldi* C. & R. Felder; f.23 *E. duponcheli* is *E. algea* Godart from Amboina; pl. 155, f.10,

E. moorei Butler (but not Felder) is *E. modesta ainoae* Bryk, to cite but a few examples. Also on the latter plate, f.24 *Idea blanchardii* Marchal from Celebes is completely omitted from the text.

Among the Pieridae, *Catopsilia crocale* with black antenna is regarded by most writers as only a form of *C. pomona* with pink antenna. The figures on pl. 159 are correctly named, the names in the text, p. 274, are wrong. The figs. 1-4 are for pl. 161, and those for pl. 161 are for pl. 159. On the same plate, f.15 is certainly not *Delias nigrina* from Australia. It looks like *D. funerea buruana* Rothschild from Buru. F.16 is *D. henningia* Eschscholtz from the Philippines, and f.17 is *D. harpalyce* Donovan from Australia.

More serious are such errors among the Satyridae as the reference of species to the wrong genus: pl. 165, figs. 7, 14, 15, 17 are all lumped under *Geitoneura* Butler, a generic name which I believe, on a quick check, has never previously been used for these species. *Hobartia* and *tasmanica* are species of *Argynnina* Butler, *kershawi* and *lathoniella* belong to *Oreixenica* Waterhouse and Lyell, a practice followed in Europe and Australia at least since the publication of Waterhouse and Lyell's "Butterflies of Australia" in 1914. One could go on and on because the Lycaenidae and Hesperiiidae could be similarly criticized (I have mentioned *M. atralba*, this surely is a grotesque figure, defying description or identification) but space forbids.

The pity of all this misplaced effort, as Miller says, is that the book is bought by keen young students who will rarely see these mistakes, and, as I have so often found, are then discouraged when they find they have been misled by errors in identification, nomenclature, etc. as in this work.

A phrase of H. M. Tomlinson's written about another book many years ago comes to mind "... a book over which the cymbals have been banged too loudly."

L. E. COUCHMAN

Dear Sir,

I enclose a short note arising from an article that appeared in the last issue [no. 4, vol. 28] of your Journal.

Checking Dr. van Someren's list of food-plants of East African Rhopalocera against my own records, I noticed against *C. cynthia* (about halfway down p. 320) is printed "Guttiferae: *Garcinia* sp. (unconfirmed Sevastopulo)." There is definitely some muddle here as I have never bred *cynthia* myself nor have I any records of its food-plant. In my counter list (food-plants and the species that feed on them) I have recorded *C. eudoxus* as having been said to eat *Garcinia*. The proofreading of this paper is most appalling, there is hardly a page without one or more spelling errors, but whether the *cynthia* entry is due to bad proofreading or an error on Dr. van Someren's part I cannot say.

D. G. SEVASTOPULO

I am very grateful for all the assistance provided by the members of the Editorial Committee of the Journal during my first year as editor. J. C. Downey and M. Toliver also assisted in special ways. The cooperation of the Executive Council and T. D. Sargent in facilitating the transition of the editorial duties is appreciated. Special recognition is due to Katherine S. Doktor-Sargent for contributing her excellent drawing of the early instar *Catocala relictata* Walker, cover illustration of Volume 29. L. LeMere, Technical Illustrator, Illinois Natural History Survey, helped in many ways with the illustrations that accompanied the submitted manuscripts. I thank my wife, Judy, for her patience and aiding with the proofreading.

GEORGE L. GODFREY

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3. FREQUENCY OF ISSUE Quarterly	3A. ANNUAL SUBSCRIPTION PRICE \$18.00 year	
4. LOCATION OF KNOWN OFFICE OF PUBLICATION (Street, city, county, state and ZIP code) (Not printers) 1041 New Hampshire Street, Lawrence, Kansas, Douglas 66044		
5. LOCATION OF THE HEADQUARTERS OR GENERAL BUSINESS OFFICES OF THE PUBLISHERS (Not printers) Same as above		
6. NAMES AND ADDRESSES OF PUBLISHER, EDITOR, AND MANAGING EDITOR		
PUBLISHER (Name and address) Lepidopterists' Society 1041 New Hampshire Street		
EDITOR (Name and address) George L. Godfrey, Illinois Natural History Survey Natural Resources Bldg. Urbana		
MANAGING EDITOR (Name and address) <div style="text-align: right;">61801</div>		
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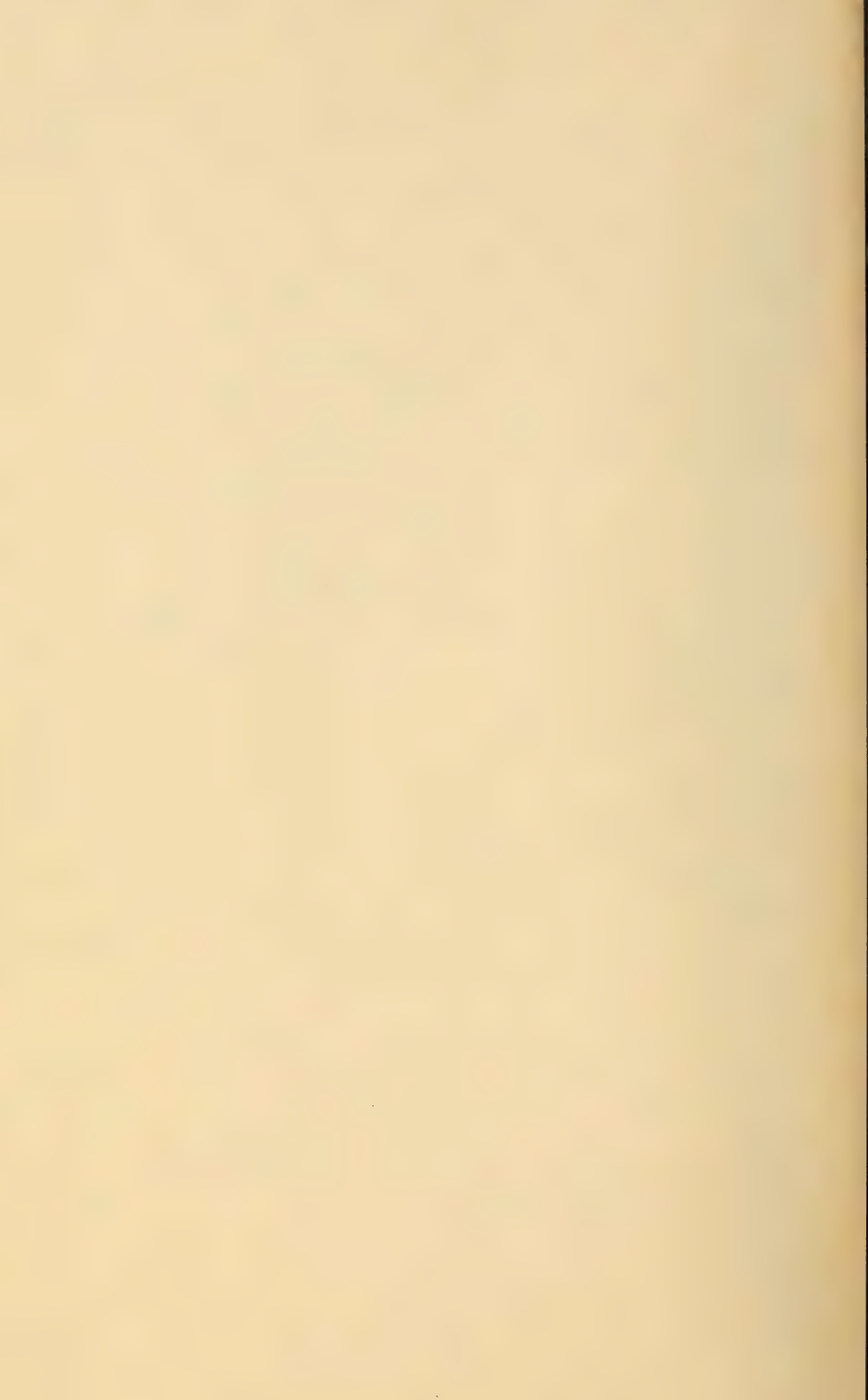
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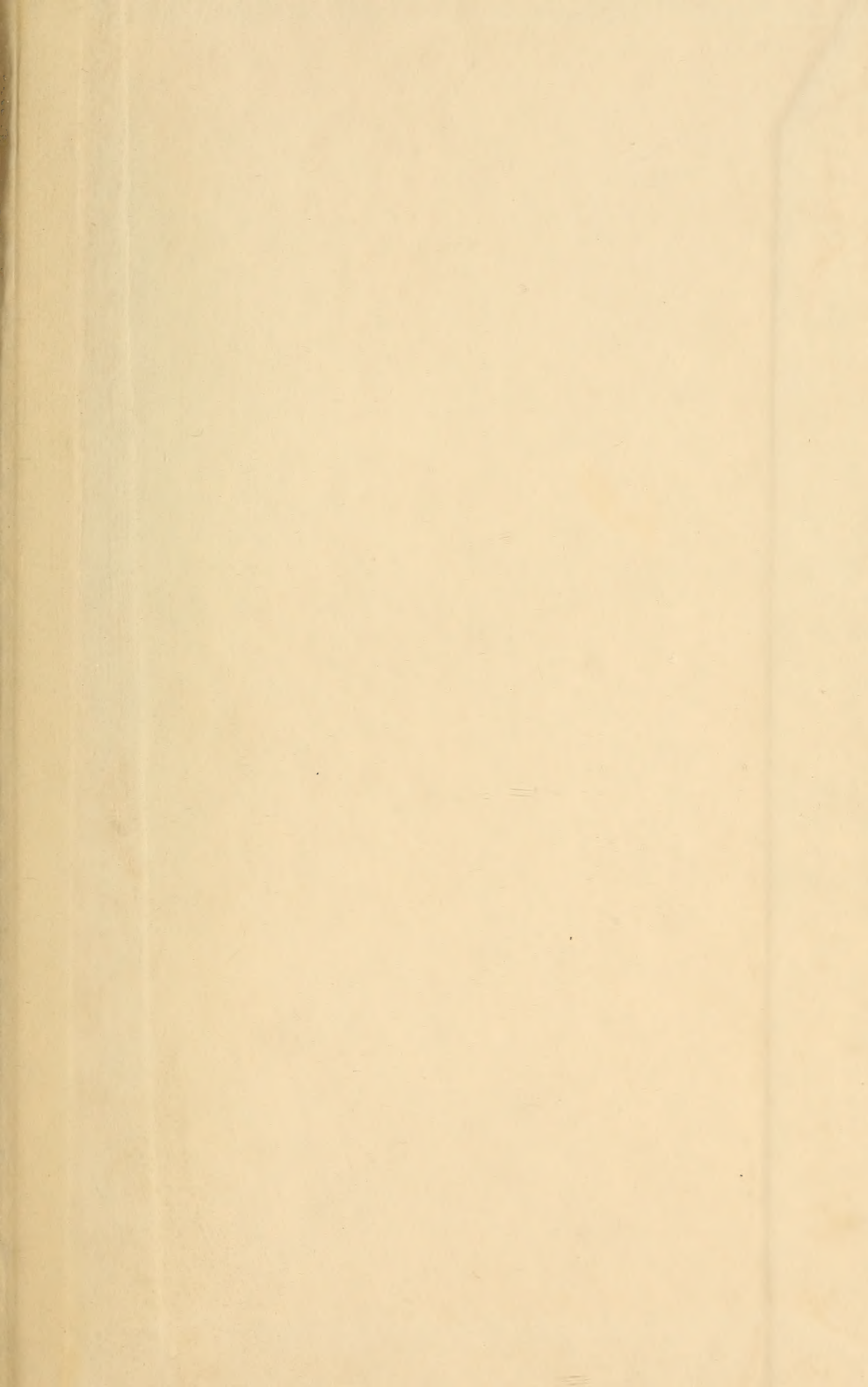
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